THE INFLUENCE OF MENTAL ACTIVITIES ON VASCULAR PROCESSES

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Mildred Elizabeth Day

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Although extensive work has been carried on in the field of blood pressure and pulse rate in connection with the study of children, the investigations have dealt to a large extent with the attempt to establish physiological norms. As a consequence we have a great amount of data on different groups of individuals at varying ages and in various parts of the world. With this as a background the necessity has arisen for intensive work to be carried out on smaller groups of subjects.

The object of the present study is an investigation of individual differences in certain vascular processes during periods of rest, physical activity, and mental activity wherever changes in these processes are observed.

In reviewing the work that has been carried out on the vascular processes, one finds that in spite of the vast amount of data, which has been collected from adult subjects, investigators differ widely in regard to norms for average systolic and diastolic blood pressure obtained for the resting condition. So many factors enter into the

determination of blood pressure readings, that the variations obtained by different individuals are not difficult to understand. The type of apparatus used, the position of the subject, the physical condition of the subject, temperature of the room, environmental disturbances, and the number of readings taken at a given period are important considerations in any investigation.

The determination of the arterial pressure in man was first made possible by von Basch who devised the sphygmomanometer in 1887. Many variations of this instrument are now in use. The principle is the cutting off of the radial pulse, by inflating a cuff placed on the upper arm just above the elbow. The cuff is then slowly deflated and the systolic pressure is determined by the reading on a dial or scale at the point where the pulse reappears. The auscultation method of determining both systolic and diastolic blood pressue in man was introduced by Korotkoff. After the radial pulse is cut off, a stethoscope is placed just below the cuff on the brachial artery. The systolic pressure is taken at the time when the first pulse wave is heard and the diastolic pressure is taken just after diastole of the heart.

In regard to norms established for the human adult, Howell (17) states that the systolic pressure as measured

in the brachial artery may be taken in round numbers as equal to 110 to 116 mm. whereas the diastolic pressure is only 65 to 75 mm.

G. N. Hartman and D. L. McDonough (13) at the University of Pennsylvania have made a recent study of arterial expansion. They are the first investigators to make a quantitative determination of the amount of increase or decrease in the volume of blood at the periphery under certain experimental conditions. Three series of determinations were made on twenty-four adult subjects:

(1) With the veins closed and arteries open.

(2) Holding the breath.

(3) During mental work (mental multiplication of a three digit by a two digit number, which kept the subject concentrated for several minutes). The results of this experiment show that the changes under the conditions with the veins closed and the arteries open are very much larger on the average than those for either mental work or holding the breath. The average ir the first case is 1.76 %, the greatest change being 3.117%, the smallest 0.80%. In the case of holding the breath the average change is 0.26%, the greatest being 1.25%. For mental work the average change was 0.16%, the greatest change being 0.38%

A series of normal determinations of systolic blood

pressure in adult men and women has been made recently by Walter C. Alvarez (2).

The total number of subjects in this study was eight thousand seven hundred and thirty-seven. The range of systolic pressure for the women was from 85-155, fifty per cent of them being between 105 and 119. The range of systolic pressure in the men was from 90 to 175, fifty per cent of them falling between 116.5-136.5. Alvarez thinks that pressure over 127 mm. in women and over 130 mm. in men is pathological.

According to the results of his experiment, the curve of average pressure for different ages, not only does not rise steadily as it has been supposed to do, but actually drops from seventeen to twenty-five mm. in women and from seventeen to twenty-one mm. in men. After the age of twenty-five, the average curve for the women rises rapidly. The rise is so much more rapid than in the men that it crosses at the age of forty and rises higher. Alvarez attributes the sexual difference in the course of the blood pressure to the functioning of the sex organs themselves.

Leonard Hill (14), after experimenting with a large number of healthy young men, with the Hill-Barnard sphygmomanometer, gives 103-105 mm. Hg. as a typical

record of systolic blood pressure for the resting position at 8:45 p. m. when the subject has had dinner and is sleepy. The pulse frequency under these conditions is 64. At 9:15 when the subject is horizontal and awake in bed the systolic pressure is 105-108 mm. Hg. When profoundly asleep the systolic pressure is again between 103-105. These results show that a fall of arterial pressure accompanies bodily rest and quiet. No normal readings are given in this work.

Weysse and Lutz (25) in reviewing the literature on diurnal variations in normal blood pressure report the following results:

1. There is a slight increase in the maximum blood pressure during the day.
2. Moderate muscular and psychical activities cause a more or less temporary rise in the maximum pressure.
3. The ingestion and digestion of food cause a rise in the maximum pressure, which remains at its height for a time and then gradually falls until the next meal (Hill says the effect of food is very slight.)
4. Maximum and minimum blood pressures are probably unequally affected by diurnal factors.

5. The pulse rate and the relative velocity of the blood flow, the product of the pulse pressure and the pulse rate (Erlanger and Hooker) seem to follow the variations in maximum pressure.

From their own investigation Weysse and Lutz (25) report a study of normal variations of the maximum, minimum blood pressure and pulse pressure, pulse rate and the relative velocity of the blood flow during the day on a group of healthy young men between nineteen and twenty-five years of age. In conclusion they state that

1. A rise of maximum pressure averaging 8 mm. occurs immediately on the ingestion of food. A gradual fall then takes place until the beginning of the next meal. There is also a slight general rise of the maximum pressure during the day.
2. The average maximum of blood pressure for healthy young men about twenty years of age is 120 mm. of Hg. This pressure obtains commonly one hour after meals. The higher maximum pressures occur immediately after meals and the lower, as a rule, immediately before meals.
3. The range of maximum pressure varies considerably in different individuals but the highest and lowest maximum pressures are practically equidistant from

the average pressure of any one individual.

4. The minimum blood pressure is very uniform throughout the day and is little affected by the ingestion and digestion of meals. There is a tendency for a slight general lowering of the minimum pressure throughout the day.

5. The average minimum blood pressure for healthy young men about twenty years of age is 85 mm.

6. Pulse pressure, pulse rate, and the relative velocity of the blood flow are increased immediately upon the ingestion of meals. They attain the maximum, as a rule, in one half hour and then decline slowly until the next meal.

7. The average pulse rate in this investigation was 72 beats per minute.

As a result of investigation on arterial pressure in healthy young men, Hill (14) reports that the systolic pressure in typical cases rises from 103-105 to between 110-115 mm. when the subject rises from bed. The pressure when sitting, after moving about is about 120 mm. If the resting position is once more assumed the pressure soon falls back again to its original level. In a typical case showing the effect of severe muscular exertion, Hill states that after running 400 yards the subject showed a rise in systolic pressure from 98 mm. to 120-130. The

corresponding pulse rate for this period was from 64 before exercise to 100 after exercise. One hour and twenty minutes later after being in a resting condition the systolic pressure was between 90-95 and the pulse rate 80 beats per minute.

W. P. Bowen (8) gives the results of an experiment showing the changes in heart-rate and blood pressure resulting from bicycling. The work done in this series of experiments consisted in driving a stationary bicycle at a constant speed against a constant resistance. The speed and resistance chosen were sufficient to cause a marked but not excessive stimulation of the circulation and to raise the temperature of the body from 1 to 2 degrees. The speed was one revolution per second, the resistance 13.3 kilograms, the amount of work approximately 400 kilogrameters per minute. The pulse rate and blood pressure were taken before, during and after thirty different working periods on the bicycle. These working periods were of various lengths, the longest being fifty minutes and the shortest three minutes. There were three male subjects aged forty-five, forty and twenty-five. In every instance, there is a sudden and rapid primary rise of pulse rate when work begins; this is followed by a more gradual secondary rise which is frequently separated from the former by a plateau. The rise of blood pressure

when work begins follows the primary rise of pulse-rate, the latter usually being complete in from one to two minutes, whereas the former continues for four minutes or more. The blood pressure after reaching a maximum in a few minutes declines slowly during the remainder of the work. The fall of blood pressure when work ceases is more rapid than the rise when work begins, but not so rapid as the primary fall of pulse rate which it accompanies. The rapid fall of pressure continues to a normal or subnormal figure without interruption; the primary fall of pulse rate, however, reaches a plateau some distance above normal. When the pressure becomes subnormal at this time it soon begins to rise again slowly, although the pulse is falling.

M. S. Pembrey (22) in discussing circulatory reactions to muscular exercise states that the increase in the rate of the heart beat is, within certain narrow limits, proportional to the work done. The pulse rate may be doubled by running down and up stairs for thirty seconds but such vigorous exercise rapidly produces dyspnoea and cannot be maintained. Pembrey gives the changes observed on a healthy well-trained young man. The pulse rate was increased from 56 to 124 and the blood pressure from 126 to 142 beats per minute. The expansion of the cutaneous arcterioles prevents the high pressure from

being maintained. Individual differences are undoubtedly important considerations in any investigation, before generalizations can be made.

F. A. Bainbridge (4) in a study of the physiology of muscular exercise states that the amount of oxygen which a man consumes is the criterion of the degree of activity of his muscules during exercise. A man, who is performing hard physical work may use eight or ten times as much oxygen as during rest and the increase must come through the circulatory and respiratory mechanisms. In general, owing to the increase in its contractile power, the output of the heart per beat is often larger and therefore the pulse rate is less frequent in the trained than in the untrained man even during rest. This author states that when a trained and an untrained man take the same amount of exercise, the pulse is less frequent, the arterial pressure is usually lower and the minute volume of the heart is smaller in the former than in the latter.

Very little work has been done on the relation between circulatory changes and mental activity. Hill (14) reports a typical case in which the systolic pressure remains about normal 103-105 mm. and the pulse frequency normal at 64 beats per minute during quiet mental work at 11:45 a. m. The details of the experiment are not given.

This author also reports a change of from 105-108 mm. to 125 mm. systolic pressure while the subject was reading an exciting book at a rapid rate between eight andnine p. m.

A study of the relation between pulse rate and mental work in adults was made by T. Arai (3) on a small number of subjects. The results from fourteen cases show that the pulse rate is invariably lower after mental work, the difference being 13.3% of the pulse rate before mental work. This author thinks, however, that the difference might be due to the fact that the subject sat for two hours with very little muscular movement, which increases the rate. The pulse rate was taken before and after two hours of mental multiplication. The individual who loses most or gains least in the course of the work shows to a considerable extent, the greatest drop, absolute or relative, in pulse rate. A similar relation of loss in ability to memorize nonsense syllables to lowering of pulse rate was found. The author concludes that on the whole, the facts from this small group of subjects favor the existence of a slight correlation between lowered pulse and lowered efficiency in intellectual work.

This experiment is of value in showing the results of

long continued work after the work has been completed. There is no record, however, of the series of changes or of what changes took place during the course of work. This is one of the points which the present piece of research has attempted to cover.

In reviewing the work that has been carried out on the vascular processes, one finds that practically nothing has been attempted in researches on children, with the exception of the extensive studies at different ages, the aim of which was to establish norms.

Gundobin (12) states that Zadek in 1880 was the first to investigate blood pressure in children. Many observers have studied the matter since, among whom may be mentioned Gumprecht, Eckert, Kolossowa, Findlay, Melvin and Murray. The largest number of observations has been carried out by Sladkof in 1903 by means of the Gartner apparatus. He examined six hundred children from one day to fifteen years old. The number of cases at each age and the number of readings taken on each child is not stated.

His table of results shows that the average systolic blood pressure at the end of the first week which for boys is 81 mm. and for girls is 77.7 mm. remains practically constant up to the age of nine years when the pressure for boys rises to 95.4 mm. and for girls to 90.5 mm. Moreover in

girls from the eleventh year when the average pressure is 103 mm. and in boys from the twelfth year when the average pressure is 104.8 mm. it rises steadily until the fifteenth year where adult pressure of about one hundred and twenty mm. is reached. The beginning of the significant rise in blood pressure occurs together with the onset of puberty and the most recent work on the subject by H. K. Faber and C. A. James (11) is in agreement with the results. It is difficult to say what influence sex exercises upon the height of the blood pressure, since in answering this question, one must take into consideration not only the age, but also the height and weight as well as the general constitution of the child. The time of day, the taking of nourishment, previous mental and physical activity are likewise not without influence on the blood pressure. In regard to the pulse in childhood, Vierordt is of the opinion that fluctuations make the establishing of norms a difficult task. In children of all ages the circulation is faster than that of adults. There is some difference of opinion regarding the influence of sex upon pulse frequency. Trousseau claims that all female children from the age of three months upward have a higher frequency than males of a corresponding age. Vierordt believes that the pulse is of equal frequency up to five years. Gundobin, however,

holds the opinion that sex itself has no bearing upon pulse frequency. It is only the weight of the child that affects it, therefore, the heavier the child the slower the pulse and as male children are on the whole larger than female children, the male pulse is slower.

Pulse pressure times pulse is a measure introduced by Erlanger (17) and discussed by Wiggers, Eddis and others, which may be regarded as a measure of cardiac output. Its main value is in estimating output in a given individual under different conditions of exercise. It is noteworthy that the pulse pressure_pulse product is practically constant up to the twelfth year and identical for the two sexes. At this time a slight progressive rise occurs which is distinctly greater for girls than for boys. Whether this indicates a preadolescent or adolescent rise in cardiac output or merely reflects a lessening of peripheral resistance or some other circulatory change incidental to adolescence, these investigators find it impossible to state with certainty.

The most recent piece of research upon the circulatory reactions to graduated exercise in normal children was carried out by M. G. Wilson(27). This study was undertaken to ascertain whether the results obtained from children were similar to those found in adults. Twenty subjects between the ages of six and thirteen were used but

unfortunately the results are not tabulated according to age.

The exercise consisted in swinging one or two dumb-bells of three, four, five, seven, and ten pounds each, from the floor to the full stretch of the arms overhead and back again between the legs at a constant rate of two seconds for each swing. This movement was repeated from ten to sixty times to increase the amount of work.

The results of these experiments give a basis for the following conclusions:

1. The circulatory reactions obtained in normal children are similar to those obtained in adults.
2. The time required for the pulse rate to return to normal does not give much information as to the "exercise tolerance" of the child.
3. The circulatory reactions immediately following similar graduated exercises at two day intervals over a period of fifteen weeks are as a rule constant.
4. "Exercise tolerance" of a child may be regarded as having been reached when a systolic blood pressure curve after exercise shows an increased rise, then a delayed rise and a prolonged fall. No investigations are reported on the relation

between, blood pressure, pulse rate and mental work in children.

In discussing the experimental results of the present study the following points must be considered both in a general way and in detail.

A comparison will be made of the relative changes in blood pressure; pulse pressure and pulse rate in young adults at rest, during physical activity and during mental activity. Pulse rate in children in relation to age and sex differences will also be studied.

Two groups of subjects were selected for this experiment, a group of adults and a school group from the fourth and fifth grades of a private school. The adult group will be considered first in the discussion.

Five young adult graduate students in Psychology, only one of whom is a woman, and one male member of the senior class, were used as reactors.

The general laboratory apparatus consisted of an adjustable hydraulic chair; a table and stand which could also be adjusted for each individual; a stop watch; a thistle stethoscope; and a spring dial sphygmomanometer of the Tycos type.

The apparatus used for physical activity consisted of a padded board one foot wide and two and a quarter feet long, with a six inch hurdle fastened crosswise in the

center. A rubber cushion three inches in diameter was placed on each side, seven inches from the hurdle. The weight used in connection with the board was a one pound wooden dumb-bell.

Three types of material were used for mental activity, the Number Work Test, Johns Hopkins Series Nos. (1) and (2); the Omitted Letter Test (Dunlap) forms (1) and (2), and reading material, which in the case of the adult subjects was the third chapter, in Christopher Morley's "The Haunted Bookshop," Titania Arrives.

The examination of each subject extended over a period of nine days, ten readings being taken on each day.

A series of ten normal readings with the reactor in the resting state were taken for the first three days of the experiment. On the six days following, four normal readings were taken, the different tests were given during the fifth, sixth, and seventh readings. In the case of physical exercise, the test was given only for the first minute during the fifth, sixth, and seventh readings. After the completion of every test period, three normal readings were taken, making a series of ten readings on every reactor for each day. The blood pressure was recorded within forty seconds and the pulse rate taken immediately afterwards for a full minute period.

Readings were taken at intervals of three minutes.

An attempt was made to make the days on which the readings were taken as nearly consecutive as possible, but an examination of the dates on each record will show what deviations from this schedule were made necessary.

All of the readings throughout this investigation were taken by the writer. It is important that all readings should be made by the same experimenter, since the personal equation has been considered to be a factor in work upon blood pressure.

In the discussion of experimental results the records of blood pressure and pulse frequency obtained from the adult reactors A, B, C, D, E, and I will be considered first.

The range in systolic pressure for the entire group, when the subject was in a resting state, is from 100 mm. to 144 mm.; the corresponding range of diastolic pressure is from 52 mm. to 78 mm. The records of blood pressure for the first day of the experiment are not noticeably different from those obtained on other normal days.

There is no regularity of increase or decrease in either systolic or diastolic pressure, which occurs during the test period or after the test period.

Reactor: (A) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	106	102	100	102	102	100	102	102	100	102		11:20:22
Dias.	72	72	72	72	70	72	72	72	70	70		
P.P.	34	30	28	30	32	28	30	30	30	32		Time
Pulse	74	71	73	75	72	71	74	75	75	73		3:30
Sys.10	106	104	102	106	102	104	102	106	102	102		11:21:22
Dias.	76	72	72	74	74	74	72	74	74	74		
P.P.	30	32	30	32	28	30	30	32	28	28		Time
Pulse	80	82	81	75	82	83	83	80	78	82		3;25
Sys.	104	104	100	102	104	106	102	102	102	100		11:23:22
Dias.	76	74	70	68	74	72	72	72	74	72		
P.P.	28	30	30	34	30	34	30	30	28	28		Time
Pulse	89	78	86	83	80	84	80	77	78	79		3:34
Sys.	104	102	104	100	106	106	108	108	102	100	NW (1)	11:24:22
Dias.	68	70	72	70	78	76	78	76	72	68		
P.P.	36	32	32	30	28	30	30	32	30	32		Time
Pulse	75	70	74	73	74	84	85	79	78	75		3:45
Sys.	120	120	114	114	114	114	116	118	110	110	NW (2)	2:9:23
Dias.	70	70	62	62	66	70	72	64	60	62		
P.P.	50	50	52	52	48	44	44	54	50	48		Time
Pulse	78	75	75	75	78	79	82	72	70	68		3:30
Sys.	112	112	106	106	106	108	112	110	104	106	Om L	2:10:23
Dias.	70	70	64	64	66	70	72	68	54	60		
P.P.	42	42	42	42	40	38	40	42	50	46		Time
Pulse	68	66	67	67	72	74	75	72	68	69		3:30
Sys.	108	106	108	108	106	108	110	110	110	98	Read	2:16:23
Dias.	68	70	72	72	68	70	68	68	64	64		
P.P.	40	36	36	36	38	38	42	42	36	34		Time
Pulse	64	73	70	72	72	73	76	70	67	63		3:30

Reactor: (A) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	116	114	116	114	114	116	110	118	118	108	DB (1)	3:5:23
Dias.	62	64	60	62	66	64	60	58	68	60		
P.P.	54	50	56	52	48	52	50	60	50	48		Time
Pulse	80	82	80	78	84	86	87	76	76	74		3:30
Sys.	114	116	116	118	110	110	108	116	114	114	DB (2)	3:10:23
Dias.	56	58	60	60	62	64	64	62	62	58		
P.P.	58	58	56	58	48	46	44	54	52	56		Time
Pulse	84	89	89	88	95	96	97	92	90	92		3:30

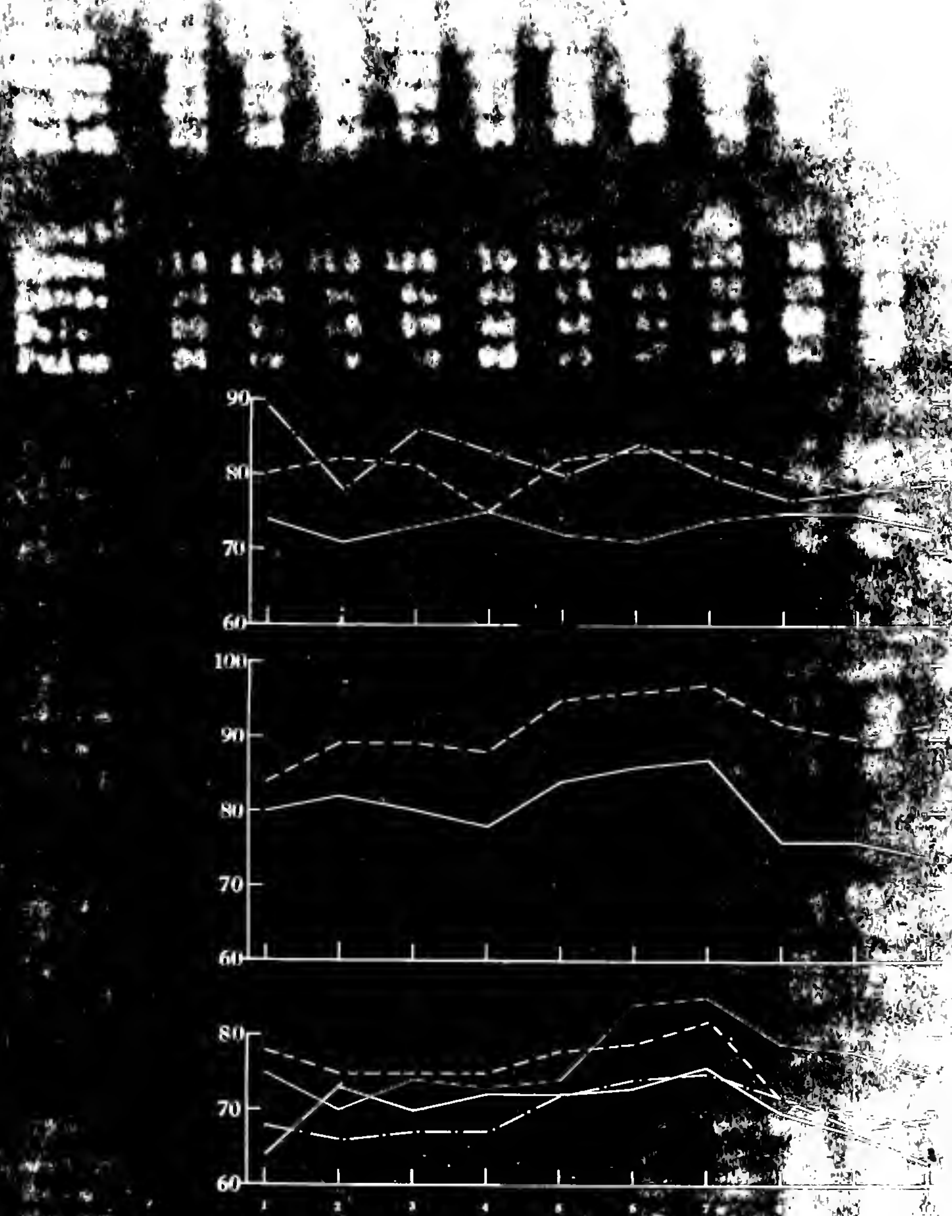

Fig. [illegible] — Pulse Re[illegible]

Reactor: (B) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	110	106	108	102	118	120	116	110	114	116		12:2:22
Dias.	68	64	66	62	70	68	64	66	68	70		
P.P.	42	42	42	40	48	52	52	44	46	46		Time
Pulse	80	79	79	78	85	80	78	78	79	78		4:30
Syss	112	110	110	112	110	108	110	112	110	112		12:9:22
Dias.	72	68	66	64	62	62	64	64	62	64		
P.P.	40	42	44	48	48	46	46	48	48	48		Time
Pulse	78	77	78	76	76	74	80	78	76	76		5:00
Sys.	106	102	104	104	106	110	106	102	106	102		1:8:23
Dias.	54	56	56	52	56	56	54	52	54	52		
P.P.	52	46	48	52	50	54	52	50	52	50		Time
Pulse	89	88	85	85	87	80	83	86	87	84		5:30
Sys.	112	114	112	118	116	120	116	122	122	110	NW (1)	1:18:23
Dias.	70	68	72	60	64	62	60	62	62	56		
P.P.	42	46	50	58	52	58	56	60	60	54		Time
Pulse	80	79	79	76	78	85	84	83	83	79		5:30
Sys.	114	114	116	114	114	118	124	112	112	114	NW (2)	1:29:23
Dias.	64	66	70	70	70	74	78	62	62	68		
P.P.	50	48	46	44	44	44	46	50	50	46		Time
Pulse	82	82	78	78	80	83	87	80	76	78		3:30
Sys.	114	112	110	110	110	110	112	110	114	114	Om L	2:1:233
Dias.	70	62	60	60	60	72	74	66	66	66		
P.P.	44	50	50	50	50	38	38	44	48	48		Time
Pulse	75	72	74	75	77	86	85	80	77	74		3:30
Sys.	112	112	108	108	108	112	114	112	106	102	Read.	2:9:23
Dias.	70	72	68	68	66	66	62	66	62	60		
P.P.	42	40	40	40	42	46	52	46	44	42		Time
Pulse	72	70	71	70	71	73	75	70	66	66		3:30

Reactor: (P) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	106	106	108	104	110	110	110	102	102	102	DB (1)	3:9:23
Dias.	68	64	62	66	70	64	62	64	68	64		
P.P.	38	42	46	38	40	46	48	38	34	38		Time
Pulse	79	82	82	80	81	70	70	79	75	78		3:30
Sys.	114	114	112	114	116	114	110	112	110	110	DB (2)	3:17:23
Dias.	68	64	64	64	66	62	66	64	62	62		
P.P.	46	50	48	50	50	52	44	48	48	38		Time
Pulse	73	72	72	72	70	72	70	66	70	74		3:30

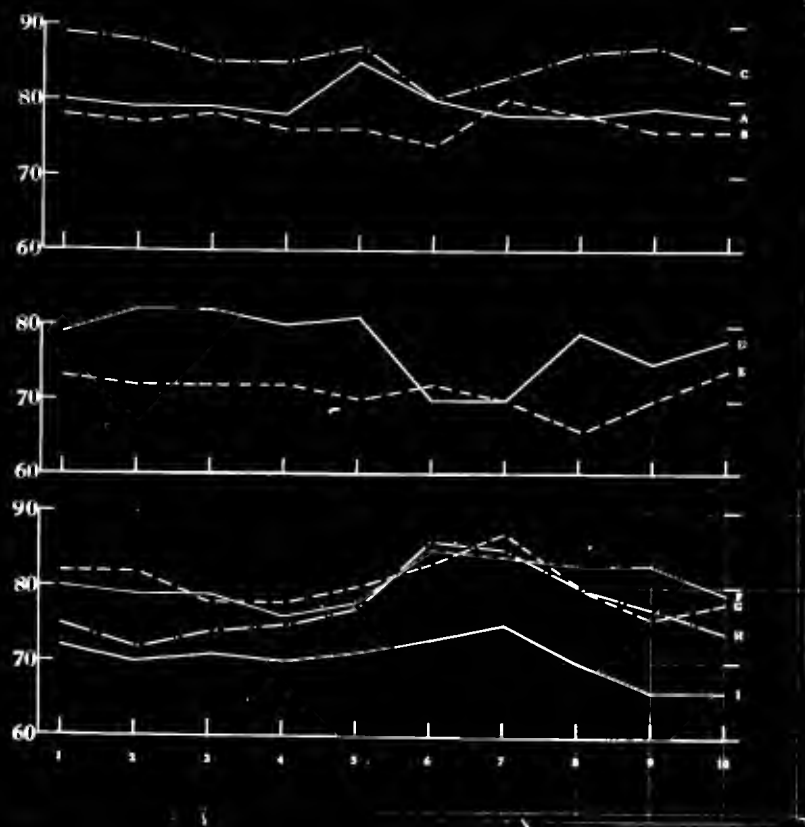

Fig. 2 - Pulse Readings - Reactor B

Reactor: (C) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	122	118	120	124	118	120	118	122	118	122		11:24:22
Dias.	62	60	62	60	62	64	62	66	62	64		
P.P.	60	58	58	64	56	56	56	56	56	58		Time
Pulse	68	69	67	64	70	66	69	68	71	66		10:45
Sys.	138	140	138	128	124	126	120	122	118	120		12: 7:22
Dias.	64	62	60	62	68	64	66	62	66	62		
P.P.	74	78	68	66	56	62	54	60	58	58		Time
Pulse	78	76	73	71	73	71	68	72	73	73		1:00
Sys.	122	120	124	126	120	118	114	122	120	122		12:14:22
Dias.	70	68	66	72	70	68	70	74	68	70		
P.P.	52	52	58	54	50	50	44	58	52	52		Time
Pulse	69	70	67	69	70	69	70	72	67	70		3:15
Sys.	110	118	116	112	112	112	124	122	112	114		12:21:22
Dias.	74	74	68	66	68	68	72	72	68	66		
P.P.	36	44	48	46	44	44	52	50	44	48		Time
Pulse	72	69	64	65	63	64	66	65	63	65		3:20
Sys.	118	122	122	124	122	118	122	130	122	118		1: 4:23
Dias.	76	78	78	76	72	68	68	80	78	76		
P.P.	42	44	44	48	50	50	54	50	44	42		Time
Pulse	70	70	69	67	69	65	65	62	65	68		3:10
Sys.	122	124	124	122	124	126	118	122	120	122		1:11:23
Dias.	58	60	58	56	54	52	60	58	60	58		
P.P.	64	64	66	66	70	74	58	64	60	64		Time
Pulse	63	64	63	66	63	67	63	64	63	65		3:20

Reactor: (C) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	145	148	148	150	146	152	148	146	152	146		1:18:23
Dias.	60	65	70	68	76	70	74	76	72	76		
P.P.	85	83	78	82	70	82	74	70	80	70		Time
Pulse	73	73	75	75	73	70	72	74	68	70		3:00
Sys.	128	120	126	126	128	130	122	132	130	126	NW(1)	1:25:23
Dias.	76	70	70	68	66	70	62	60	64	64		
P.P.	52	50	56	58	62	60	70	72	66	62		Time
Pulse	73	71	70	71	73	76	77	74	72	70		3:00
Sys.	130	130	132	132	138	140	144	144	140	142	NW(2)	2:8:23
Dias.	54	54	52	50	58	58	60	60	64	60		
P.P.	76	76	80	82	80	82	84	84	76	82		Time
Pulse	74	70	74	73	75	81	85	76	77	74		3:00
Sys.	124	130	128	128	130	134	136	128	130	140	Om L	2:15:23
Dias.	54	56	56	56	60	52	56	60	60	58		
P.P.	70	74	72	72	70	82	80	68	70	82		Time
Pulse	69	67	67	67	68	70	76	72	71	70		3:15
Sys.	120	118	118	120	120	122	122	122	112	114	Read	2:23:23
Dias.	60	56	56	56	58	62	68	54	54	58		
P.P.	60	62	62	64	62	60	54	68	58	56		Time
Pulse	74	73	73	73	73	75	75	70	70	70		3:15
Sys.	114	120	122	122	124	120	118	116	116	118	DB(1)	3:1:23
Dias.	62	54	58	60	62	54	50	50	52	58		
P.P.	52	56	64	62	62	66	68	66	64	60		Time
Pulse	67	65	65	65	69	77	84	64	67	68		3:15
Sys.	142	142	140	142	140	142	144	136	150	148	DB(2)	3:8:23
Dias.	66	68	58	62	70	68	64	58	64	66		
P.P.	76	74	82	80	70	74	80	78	86	82		Time
Pulse	69	69	67	67	72	76	84	70	75	73		3:20

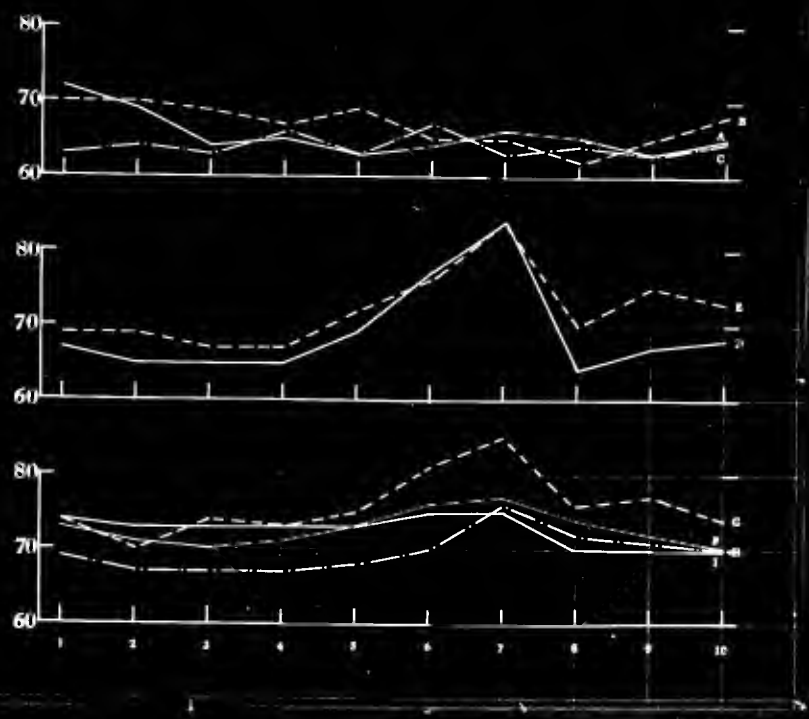

Fig. 3 - Pulse Readings - Reactor C

Reactor: (D) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	110	108	108	102	100	100	106	104	100	10		1:4:[illegible]
Dias.	58	62	64	60	58	54	58	54	56	54		
P.P.	42	40	44	42	42	46	48	50	44	48		Time
Pulse	76	77	79	75	77	76	75	75	76	78		3:30
Sys.	114	110	112	112	114	110	112	110	110	110		1:10:23
Dias.	68	70	68	68	66	64	68	62	62	60		
P.P.	46	40	44	44	48	46	44	48	48	50		Time
Pulse	75	75	78	78	79	78	77	78	79	79		3:30
Sys.	112	108	110	106	108	110	108	110	106	110		1:16:23
Dias.	60	62	62	60	58	54	58	60	58	60		
P.P.	52	46	48	46	50	56	50	50	48	50		Time
Pulse	75	76	76	75	78	74	75	77	77	76		3:40
Sys.	112	110	110	112	112	114	112	110	110	110	NA(1)	1:23:23
Dias.	62	60	64	66	66	70	72	68	62	64		
P.P.	50	50	46	46	46	44	40	42	48	46		Time
Pulse	77	78	76	77	82	84	85	78	78	78		3:35
Sys.	116	116	110	110	110	114	118	114	108	108	NA(2)	1:30:23
Dias.	70	68	64	62	64	70	72	64	58	60		
P.P.	46	48	46	48	46	44	46	50	50	48		Time
Pulse	78	78	79	79	80	83	87	82	82	80		3:30
Sys.	108	108	104	104	104	108	116	110	104	104	0mL	2:6:23
Dias.	58	62	60	60	62	64	70	66	62	64		
P.P.	50	46	44	44	42	44	46	54	42	40		Time
Pulse	87	85	82	82	83	91	94	88	83	84		3:30

Reactor: (2) Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	108	110	110	110	110	114	114	108	108	108	Read	2:20:13
Dias.	60	58	56	56	54	50	52	58	58	58		
P.P.	48	52	54	54	56	64	62	50	50	50		Time
Pulse	82	82	81	81	81	82	78	82	81	80		3:30
Sys.	104	104	104	104	104	100	100	102	102	102	DB(1)	3:13:23
Dias.	64	62	60	60	68	58	60	64	64	62		
P.P.	40	42	44	44	36	42	40	38	38	40		Time
Pulse	80	78	76	76	81	82	90	78	70	73		3:30
Sys.	108	104	106	108	104	108	110	100	100	102	DB(2)	3:20:23
Dias.	62	60	64	60	64	64	64	60	58	62		
P.P.	46	44	42	48	40	44	46	40	42	40		Time
Pulse	85	84	87	86	87	83	87	83	84	83		3:30

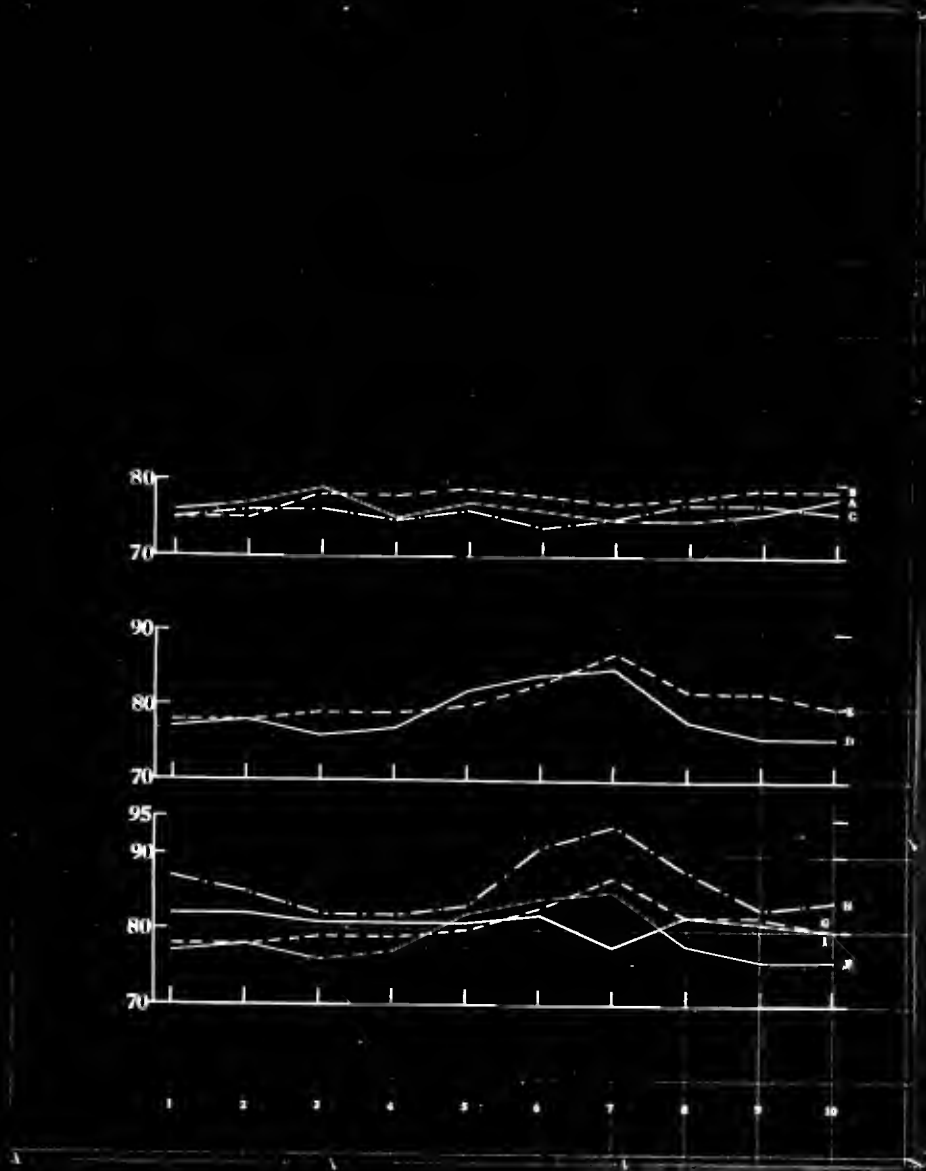

Fig. 4 - Pulse Readings - Reactor II

Reactor: (E) Age: Adult

Read:1	1	22	3	4	5	6	7	8	9	10	Test	Date
Sys.	118	114	112	114	110	110	112	114	108	114		1: 8:23
Dias.	68	64	66	64	64	64	62	64	62	66		
P.P.	50	50	46	50	46	46	50	50	46	48		Time
Pulse	65	65	65	65	67	65	65	65	63	64		10:30
Sys.	110	114	112	110	112	108	108	110	110	108		1; 9:23
Dias.	64	68	64	60	66	64	64	66	66	62		
P.P.	46	46	48	50	46	44	44	44	44	46		Time
Pulse	65	63	63	64	63	62	64	64	65	64		10:30
Sys.	120	118	120	116	120	114	116	120	118	118		1:10:23
Dias.	64	74	72	68	70	70	68	70	70	68		
P.P.	56	34	48	50	44	48	50	48	48	50		Time
Pulse	65	65	63	61	65	61	62	62	65	63		10:30
Sys.	112	108	108	110	110	112	118	108	110	110	NW(1)	1:15:23
Dias.	64	58	62	56	64	62	66	60	58	58		
P.P.	48	50	46	54	46	50	52	48	52	52		Time
Pulse	70	70	72	72	74	79	84	66	73	72		10:30
Sys.	110	114	114	112	112	120	120	120	120	110	NW(2)	1:20:23
Dias.	64	66	66	64	66	70	70	68	58	62		
P.P.	46	48	48	48	46	50	50	52	62	48		Time
Pulse	65	65	64	65	67	78	83	77	67	67		10:30
Sys.	110	114	112	110	110	112	112	104	108	110	Om L	1:22:23
Dias.	70	68	66	68	68	72	74	64	68	68		
P.P.	40	46	46	42	42	40	38	40	40	42		Time
Pulse	60	60	60	60	61	67	73	60	60	60		10:30
Sys.	114	112	108	112	112	116	116	112	108	108	Read	2: 6:23
Dias.	68	66	66	66	64	62	62	66	64	66		
P.P.	46	46	42	46	48	54	54	46	44	44		Time
Pulse	62	63	62	62	67	66	65	62	62	63		10:30
Sys.	122	124	118	118	118	118	122	114	108	114	DB(1)	3: 8:23
Dias.	64	68	64	64	60	60	62	70	66	70		
P.P.	58	56	54	54	58	58	60	44	42	44		Time
Pulse	63	64	64	63	71	76	76	66	64	60		10:30

Reactor: (E) Age Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	114	116	116	114	118	114	112	112	110	112	DB(2)	3:15:23
Dias.	70	70	70	70	72	76	76	64	62	64		
P.P.	44	46	46	44	46	38	36	48	48	48		Time
Pulse	69	70	69	69	90	88	88	80	68	65		10:30
Sys.	126	122	116	116	118	122	124	120	120	120		4:6:23
Dias.	68	66	62	66	66	68	66	64	68	64		
P.P.	58	56	54	50	52	54	58	56	52	56		Time
Pulse	65	65	66	64	70	69	67	67	66	66		10:30

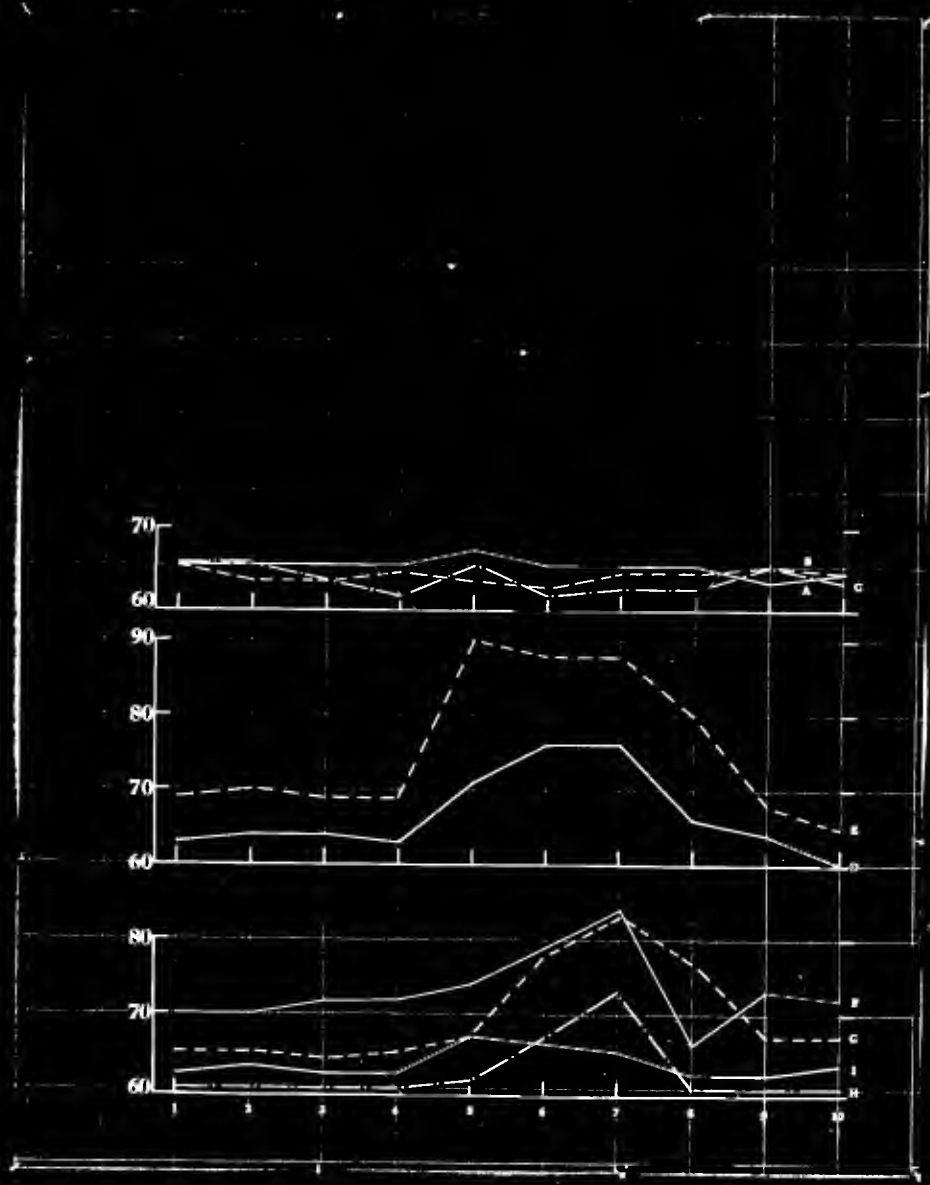

Fig. 5 – Pulse Readings – Reactor E

Reactor: I Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	130	128	130	140	138	138	138	140	142	140		2:27:23
Dias.	64	58	54	58	64	62	66	62	68	64		
P.P.	66	70	76	82	74	76	72	78	64	76		Time
Pulse	57	61	62	65	62	64	62	62	62	62		11:30
Sys.	132	140	134	134	136	128	138	136	140	142		2:28:23
Dias.	62	60	64	64	62	60	64	64	66	70		
P.P.	70	80	70	70	74	68	74	72	74	72		Time
Pulse	77	79	78	78	79	76	74	74	74	74		11:30
Sys.	138	140	138	134	136	132	130	132	130	132		3:3:23
Dias.	70	74	74	72	76	72	68	72	72	70		
P.P.	68	66	64	62	60	60	62	60	58	62		Time
Pulse	80	80	79	76	75	77	76	76	77	76		11:30
Sys.	142	142	140	140	138	142	144	140	136	130	NW (1)	3:5:23
Dias.	68	70	66	66	62	76	80	78	64	66		
P.P.	74	72	74	74	76	66	64	62	72	64		Time
Pulse	62	64	64	64	70	78	76	71	70	65		11:30
Sys.	136	136	138	138	138	140	142	132	134	130	NW (1)	3:6:23
Dias.	78	76	78	78	84	86	86	78	68	74		
P.P.	58	60	60	60	54	54	56	54	66	56		Time
Pulse	68	72	72	73	74	83	82	71	69	70		11:30
Sys.	142	138	144	140	140	144	140	136	134	142	Cm L	3:7:23
Dias.	68	64	70	68	78	84	88	78	78	76		
P.P.	74	74	74	72	62	60	52	58	56	66		Time
Pulse	72	73	72	72	77	80	78	69	74	70		11:30
Sys.	130	132	124	122	126	128	130	124	120	120	Read	3:9:23
Dias.	70	70	64	66	74	78	82	74	80	80		
P.P.	60	62	60	56	52	50	48	50	40	40		Time
Pulse	68	65	65	63	66	66	65	64	62	59		11:30

Reactor: I Age: Adult

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	142	140	144	144	144	130	126	118	122	122	DB (1)	3:12:23
Dias.	68	66	70	70	76	80	82	70	74	72		
P.P.	74	74	74	74	68	50	44	48	48	50		Time
Pulse	78	77	78	76	82	83	84	76	74	78		11:30
Sys.	138	136	136	136	138	140	144	140	134	134	DB (1)	3:13:23
Dias.	68	68	72	70	72	76	82	80	74	80		
P.P.	70	68	64	66	66	64	62	60	60	54		Time
Pulse	70	72	72	72	77	86	91	87	72	68		11:30

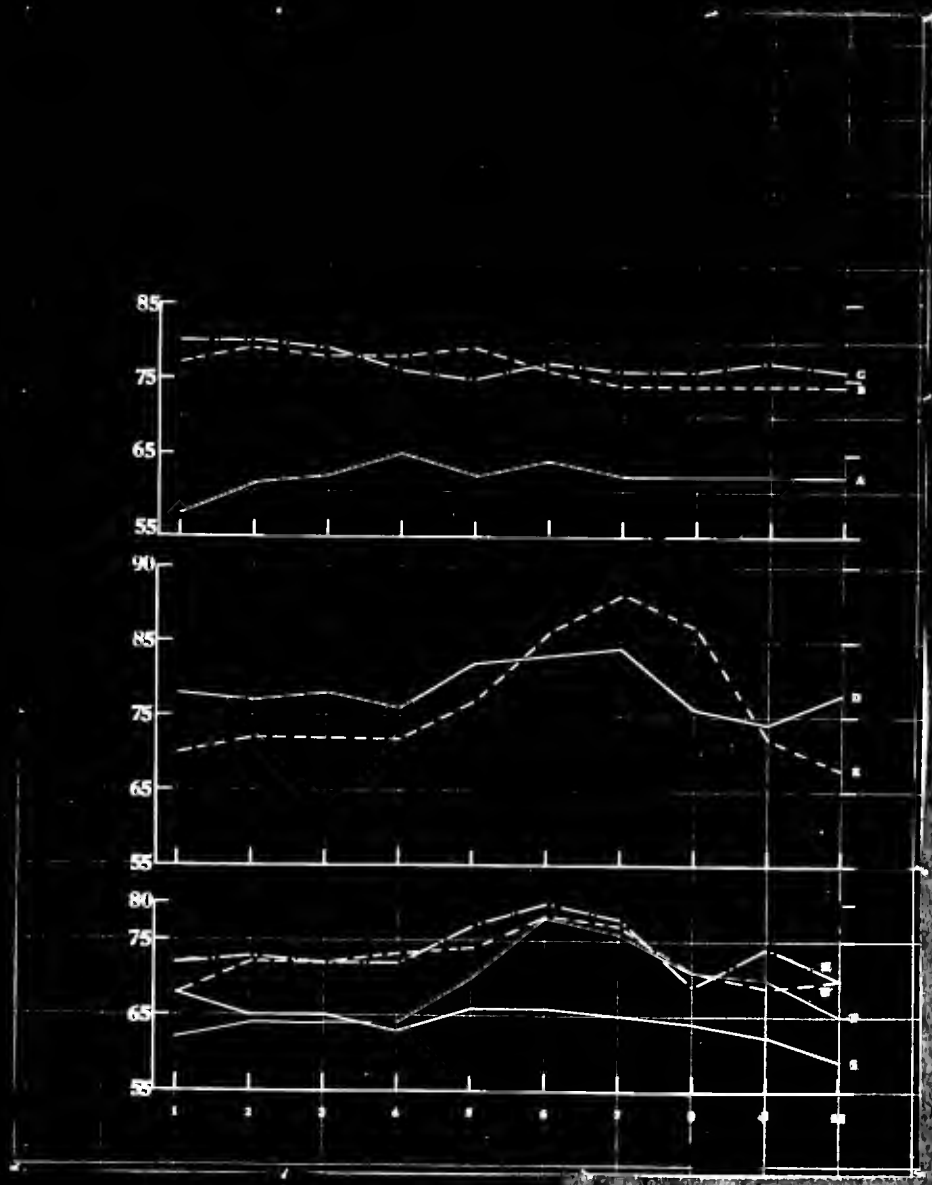

Fig. 9 — Pulse Readings — Reactor I

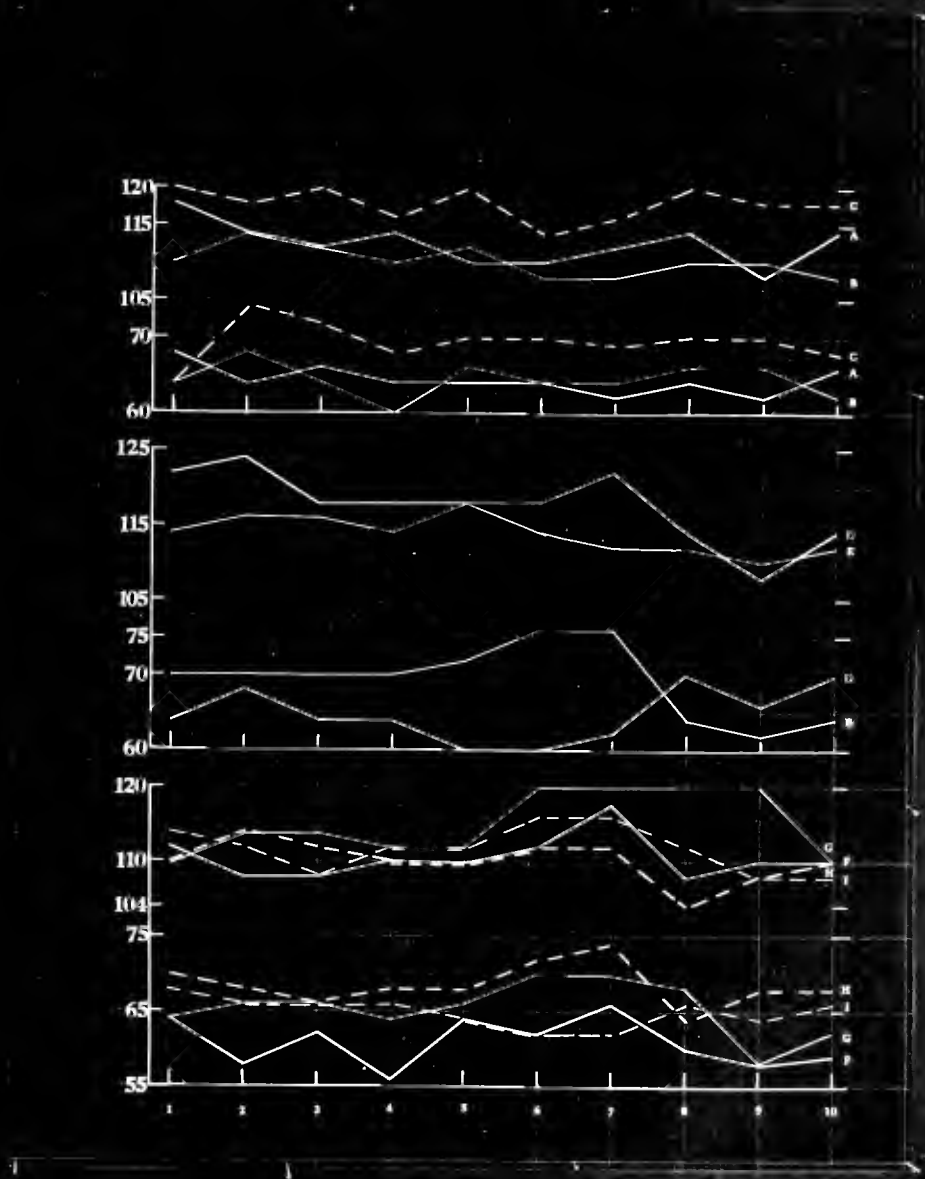

Fig. 10 – Blood Pressure Readings - Reactor E

The individual fluctuations between every two successive readings for every day have been tabulated in Tables (1) to (9). From a careful examination of them, we must conclude that in the case of this group of adult reactors, the blood pressure records do not have any significant relation to the test material which was given.

The pulse rate curves for the adult reactors do not fluctuate with the blood pressure readings. All of the pulse rate curves are characterized by a definite trend on the days when either physical or mental exercise was given.

The pulse curves on normal days when no test was given fluctuate irregularly. The range for the whole group is from 60 to 91 beats per second although the greatest number of readings fall between the frequencies 65 and 80 beats per second.

Whenever the physical exercise was given, the pulse rate increased definitely during the test period (the fifth, sixth, and seventh readings) in all of the reactors, with the exception of reactor B, whose pulse rate remained practically normal on both days of physical exercise. The highest pulse rate attained by any reactor during physical exercise was 98 and the lowest pulse rate for the same period was 67 beats per second.

The record shows that in the case of every reactor there is a marked decrease in pulse rate in the readings taken after the cessation of physical exercise. The decrease in rate is observable in the case of reactor B only in test (2) of physical exercise.

A survey of the changes occurring in pulse rate during mental exercise in the adult reactors range from 61 to 94 beats per second. Just as was noted in the case of physical exercise the pulse rate during mental exercise increases throughout the fifth, sixth, and seventh readings for all of the tests given.

A computation of the total increases in rate for all of the adult reactors in the various tests shows that the greatest gain in rate was during the Number Work Test (2). The increase in rate during the other tests occurred in the following order: Omitted Letter Test; Number Work Test (1) and the Reading Test.

There were fourteen children used as reactors in this series of experiments. The range of ages was from eight years two months, to fifteen years three months. Eleven of the children (Reactors (1) to (11)) were selected from the fourth and fifth grade groups in a school which offered excellent facilities for the experimentation. The other three children (Reactors (G), (F), and (H)) are from the sixth grade, and the first and second year of high

school.

The group of three children, Reactors (G), (F), and (H), all of whom are girls, will be considered first, since the method of procedure and apparatus used upon them were the same as that described for the adult reactors. In the case of Reactor (G) the selections for the reading experiment were "The Sunken Treasure" by Hawthorne and "The Lady of the Grey Isle" by Nelson Antrim Crawford.

An examination of the blood pressure records for Reactors (F), (G), and (H) shows that the total range of systolic pressure for all three Reactors in all of the tests is from 94 mm. to 122 mm. These extremes occur only once, the majority of readings falling between 104 and 116 mm. The lowest point in diastolic pressure recorded in any case was 40 mm. and the highest 70 mm. As in the case of systolic pressure these extremes occurred infrequently and the greater number of readings ranged between 50 and 64 mm.

There is no observable change in the course of the records for the first day, which might be attributed to the beginning of a new experience. The highest point is 116 mm. which occurs once for Reactor (H) and the lowest point is 104 mm. which likewise occurs only once in the record of Reactor (G). There are no conspicuous

Reactor: (F) Age: 13

Read:1	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	110	108	110	106	108	106	110	110	110	108		1:9:23
Dias.	58	56	54	52	56	54	56	56	56	54		
P.P.	52	52	56	54	52	52	54	54	54	54		Time
Pulse	75	75	76	74	74	74	76	76	76	74		5:00
Sys.	108	112	110	108	108	106	110	106	104	104		1:11:23
Dias.	60	58	56	56	56	54	58	56	56	56		
P.P.	48	54	54	52	52	52	52	50	48	48		Time
Pulse	70	74	73	73	73	74	75	75	73	75		5:00
Sys.	106	104	106	102	104	106	100	100	102	104		1:16:23
Dias.	56	48	52	44	50	48	46	44	46	50		
P.P.	50	56	54	58	54	58	54	56	56	54		Time
Pulse	76	74	72	72	71	71	72	70	70	71		5:00
Sys.	106	108	108	108	108	110	116	116	112	106	NW (1)	1:23:23
Dias.	58	58	56	56	56	58	58	60	58	58		
P.I.	48	50	52	50	52	52	58	56	54	48		Time
Pulse	80	80	78	78	78	83	82	76	74	73		5:10
Sys.	116	112	114	112	112	118	118	116	110	110	NW (2)	1:30:23
Dias.	58	54	50	54	54	52	52	46	40	40		
P.P.	58	58	64	58	58	66	66	70	70	70		Time
Pulse	79	78	78	76	77	84	83	76	72	70		5:00
Sys.	112	112	110	108	110	116	118	104	104	104	Cm L	2:1:23
Dias.	56	54	56	54	58	60	60	50	50	50		
P.P.	56	58	54	54	52	56	58	54	54	54		Time
Pulse	76	76	76	76	82	84	82	70	70	72		5:00
Sys.	110	112	112	106	106	110	108	108	102	104	Read	2:8:23
Dias.	70	72	70	64	64	66	62	62	56	50		
P.P.	40	40	42	42	42	44	46	46	46	54		Time
Pulse	79	78	78	76	78	80	81	78	74	74		5:00

Reactor: (F) Age: 13

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	104	108	108	106	108	110	110	102	104	104	DB (1)	3:1:23
Dias.	68	64	58	58	58	60	60	58	62	60		
P.P.	36	34	50	48	50	50	50	44	42	44		Time
Pulse	68	67	67	67	69	70	79	67	69	68		5:00
Sys.	104	104	104	104	106	108	106	98	100	104	DB ("2)	3:13:23
Dias.	68	70	70	66	70	70	68	64	60	62		
P.P.	36	34	34	38	36	38	38	34	40	42		Time
Pulse	78	76	77	77	79	80	82	79	76	71		5:00

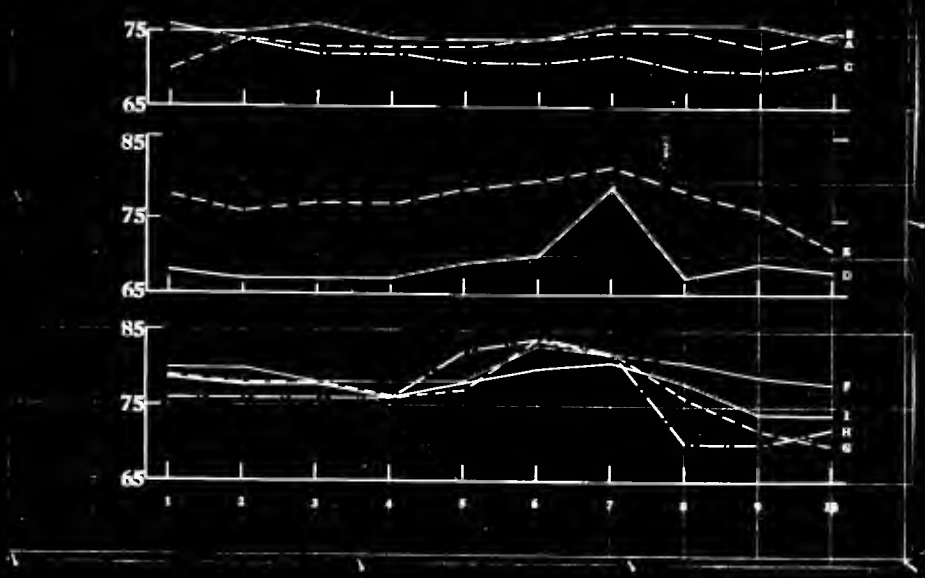

Fig. 6' – Pulse Readings – Reactor F

Reactor: G Age: 11

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	112	106	108	104	108	106	108	104	108	108		1:13:23
Dias.	50	46	48	48	50	46	50	52	48	46		
P.P.	62	60	60	56	58	60	58	52	60	62		Time
Pulse	77	76	78	78	76	77	78	76	76	77		10:30
Sys.	112	106	108	110	104	106	108	104	108	110		1:20:23
Dias.	54	50	46	44	40	42	46	42	44	48		
P.P.	58	56	62	66	64	64	62	62	64	62		Time
Pulse	75	75	76	73	76	73	77	77	76	76		11:30
Sys.	110	112	114	112	110	110	106	106	108	110		1:27:23
Dias.	56	54	52	52	50	50	48	48	52	54		
P.P.	54	58	62	60	60	60	58	58	56	56		Time
Pulse	89	89	87	86	86	86	82	82	82	82		10:30
Sys.	112	116	114	114	116	118	116	108	112	110	NW (1)	3:3:23
Dias.	48	50	48	48	46	42	42	46	48	46		
P.P.	64	66	66	66	70	76	74	62	64	64		Time
Pulse	85	83	84	84	84	87	86	82	82	83		9:30
Sys.	116	116	116	116	120	122	122	116	110	110	NW (2)	3:10:23
Dias.	56	54	44	44	50	50	56	54	42	42		
P.P.	60	62	72	72	70	72	66	62	68	68		Time
Pulse	79	78	75	75	79	79	80	73	75	75		9:30
Sys.	112	110	110	112	112	110	110	104	108	108	Om L	3:17:23
Dias.	44	44	46	44	42	44	48	44	44	48		
P.P.	68	66	64	68	70	66	62	60	64	60		Time
Pulse	82	80	80	81	79	83	84	78	79	78		9:30
Sys.	114	110	112	108	112	108	102	104	102	104	Read	3:23:23
Dias.	50	50	52	50	50	54	54	48	48	50		
P.P.	64	60	60	58	62	54	48	56	54	54		Time
Pulse	82	82	83	82	81	86	87	81	80	77		10:20

Reactor: G Age: 11

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	110	108	108	108	108	110	106	104	104	102	DB (1)	4:7:23
Dias.	48	44	48	50	54	54	52	48	48	48		
P.P.	62	64	60	58	54	56	54	56	56	54		Time
Pulse	77	75	74	76	81	84	88	79	75	77		9:30
Sys.	104	102	106	102	102	102	104	102	102	104	DB (2)	5:5:23
Dias.	58	56	54	56	54	58	54	54	54	54		
P.P.	46	46	52	46	48	44	50	48	48	50		Time
Pulse	77	78	76	75	79	84	89	80	77	79		9:30

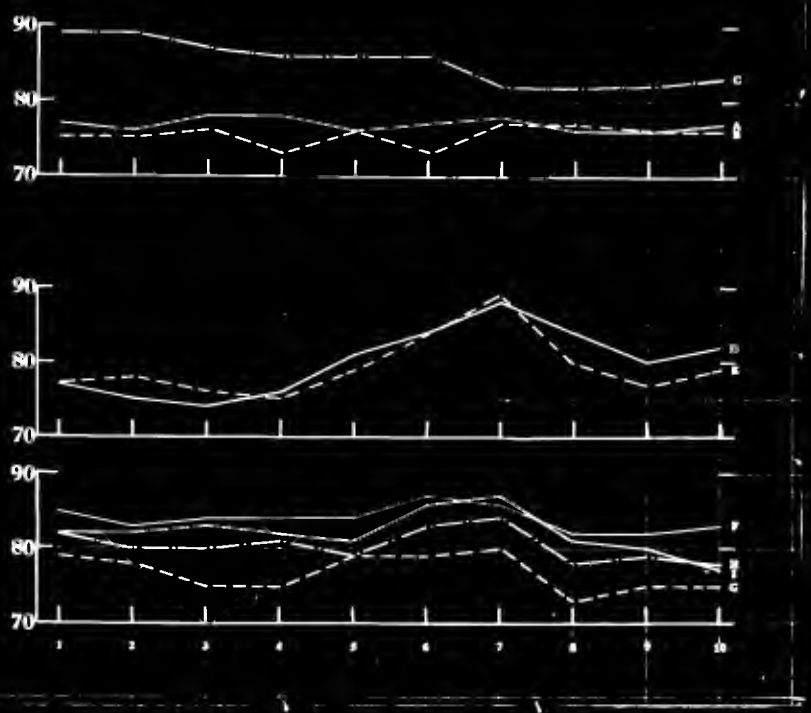

Fig. 7 – Pulse Readings – Reactor G

Reactor: H Age: 15

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys:	110	114	116	112	112	110	108	110	108	110		1:31:23
Dias.	64	68	68	64	62	62	62	64	58	54		
P.P.	46	46	48	48	50	48	46	46	50	56		Time
Pulse	80	79	79	79	79	79	78	79	80	78		4:15
Sys.	110	106	104	108	106	108	106	104	104	106		2:1:23
Dias.	64	60	58	62	60	58	62	60	62	66		
P.P.	46	46	56	46	46	50	44	44	42	40		Time
Pulse	74	76	76	76	75	75	75	74	75	73		4:00
Sys.	112	116	116	114	116	118	114	112	112	112		2:7:23
Dias.	64	58	58	56	54	60	60	58	64	60		
P.P.	48	58	58	58	62	58	54	54	48	52		Time
Pulse	80	77	77	77	78	77	78	78	76	76		4:00
Sys.	110	112	106	106	106	106	106	104	106	106	NW (1)	2:19:23
Dias.	50	50	52	52	58	64	70	62	60	58		
P.P.	60	62	54	54	48	42	36	42	46	48		Time
Pulse	74	73	75	73	79	85	85	76	76	74		3:30
Sys.	114	114	112	112	112	116	116	108	104	102	NW (2)	2:28:23
Dias.	66	64	58	58	60	66	64	64	60	56		
P.P.	48	50	54	54	52	50	52	44	44	46		Time
Pulse	82	78	72	73	83	84	83	78	78	78		3:30
Sys.	118	110	112	108	112	116	116	106	100	100	On L	3:14:23
Dias.	56	54	56	54	60	66	60	44	50	52		
P.P.	62	56	56	54	52	50	50	62	50	48		Time
Pulse	82	81	82	78	82	87	92	84	75	80		3:30
Sys.	110	104	104	104	100	100	102	96	96	94	Read	3:19:23
Dias.	50	48	48	48	56	56	54	48	50	46		
P.P.	60	56	56	56	44	44	46	48	46	48		Time
Pulse	70	67	70	67	71	65	67	68	65	65		3:30

Reactor: H Age: 15

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Sys.	104	106	106	106	104	100	102	100	104	100	DB (1)	3:21:23
Dias.	62	58	60	58	62	64	60	58	58	58		
P.P.	42	48	46	48	42	36	42	42	46	42		Time
Pulse	75	77	75	75	79	84	87	79	74	69		3:30
Sys.	108	110	108	108	104	100	98	98	98	100	DB (2)	3:26:23
Dias.	64	62	60	60	62	62	64	60	60	58		
P.P.	34	48	48	48	42	38	34	38	38	42		Time
Pulse	80	80	76	77	82	87	88	79	72	73		3:30

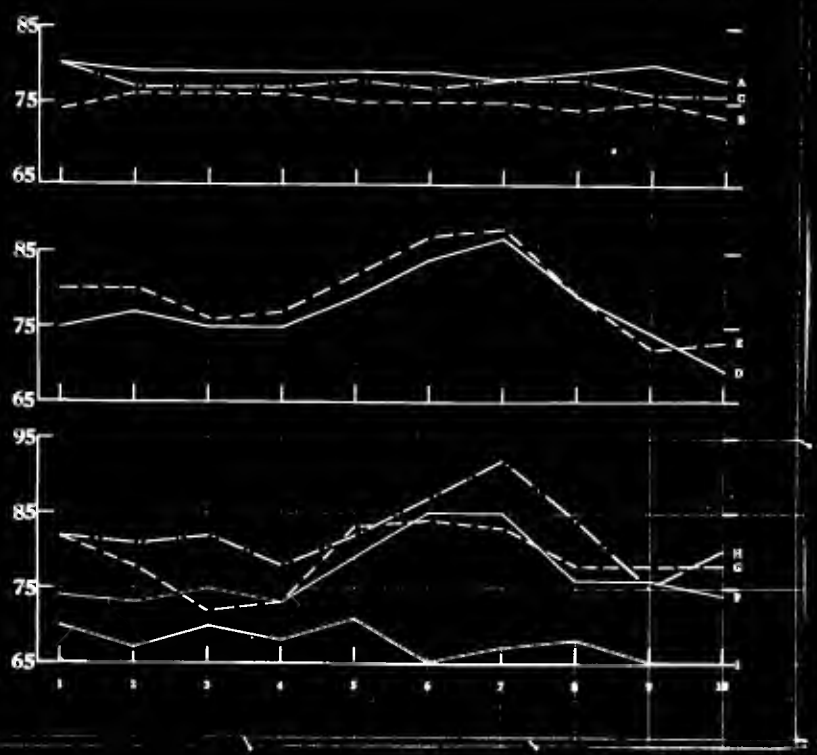

Fig. 8 — Pulse Readings — Reactor H

fluctuations in the normal blood pressure records of these three reactors. The individual pulse pressure curves also run quite regularly. The highest point reached is 64 and the lowest in any normal record is 40.

The records for the days upon which physical exercise is given are of the same general type as those taken on the normal days, slight fluctuations occurring throughout. The pulse pressure for Reactor (F) on these days is lower than in the normal records, the range being from 34 to 50. The test period does not seem to be a factor in this difference.

The highest point reached in systolic pressure during mental exercise was 122 mm. and the lowest point was 100 mm. In view of the irregularity of the slight changes which occur between successive readings, no significance can be attached to any of the fluctuations.

A study of the pulse rate records for Reactors (F), (G) and (H) shows that the fluctuations do not occur regularly with changes in blood pressure. The lowest pulse rate for any of these reactors in the resting state is 67 beats per minute; the highest rate is 89. There is a general tendency for the rate to decrease slightly on the second reading. The fluctuations, however, during the readings while at rest are irregular and in only one case is there a difference between two successive readings

as great as six points.

Since the tests when given were begun with the fifth reading and continued through the seventh, any changes in rate occurring after the fourth reading must receive careful consideration. In all three cases when both physical exercise tests were given, the pulse frequency increases with the beginning of the test. The largest increase observed is 5 and the smallest is 2. These numbers, although not large in themselves, are important because of the definite uniformity of increase in the curve. There is an increase in rate in each physical exercise curve during the fifth, sixth, and seventh readings. Upon cessation of exercise, every reactor shows a decrease in pulse rate, the largest fall being 12 points. All of the pulse rate curves decrease during the last three readings. In one instance the final rate is the same as the initial reading, and in only one case is it two points above.

The same general tendency noted in the curves for physical exercise is observable in all of the records taken when mental exercise was given. The total increase in rate in each of these tests for the three reactors was too close to provide a basis for any distinction being drawn between them. On the whole, the reading test seems

to have been accompanied by a smaller change in pulse rate than any of the other tests.

The experimental work carried out upon Reactors 1, 3, 4, 6, 8, 10, 11 (boys) and Reactors 2, 5, 7, 9 (girls) will now be discussed. The records upon all of these reactors were taken in an experimental room at the school. Since blood pressure readings were omitted and pulse rate alone was taken, the apparatus consisted of an adjustable desk and chair with a cushion for the head. The procedure of taking pulse rate was the same as that previously described , the count being taken for one minute by a stop watch.

The test material and the procedure of giving them was the same as in the case of the adult reactors described in a previous section, except that for reading material, the "Sunken Treasure," by Hawthorne was substituted for Morley's "The Haunted Bookshop" which was used for the adults.

In studying the records of reactors (1) to (11) we have only pulse rate to consider, since no blood pressure readings were taken in these cases.

The range of normal pulse rate for all of these reactors in the resting position is from 77 to 108 beats per minute. The rates between 85 and 94 are the most frequent in occurrence. The range of rates for the first

Reactor: (1) Age: 9 11

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	89	87	80	89	80	88	85	89	87	89		12:11:22
Pulse	102	87	82	81	84	85	85	86	83	86		12:12:22
Pulse	95	80	86	78	85	87	84	88	89	87		12:14:22
Pulse	81	85	84	85	88	92	98	90	78	78	DB(1)	12:15:22
Pulse	89	84	84	80	92	93	122	104	93	80	DB(2)	12:18:22
Pulse	88	84	82	84	83	97	97	92	75	76	NW(1)	12:20:22
Pulse	80	82	85	82	87	90	97	88	88	77	NW(2)	12:21:22
Pulse	87	88	86	88	87	88	92	95	84	87	Om L	1:11:22
Pulse	87	87	85	85	87	89	90	90	88	84	Read	1:12:22

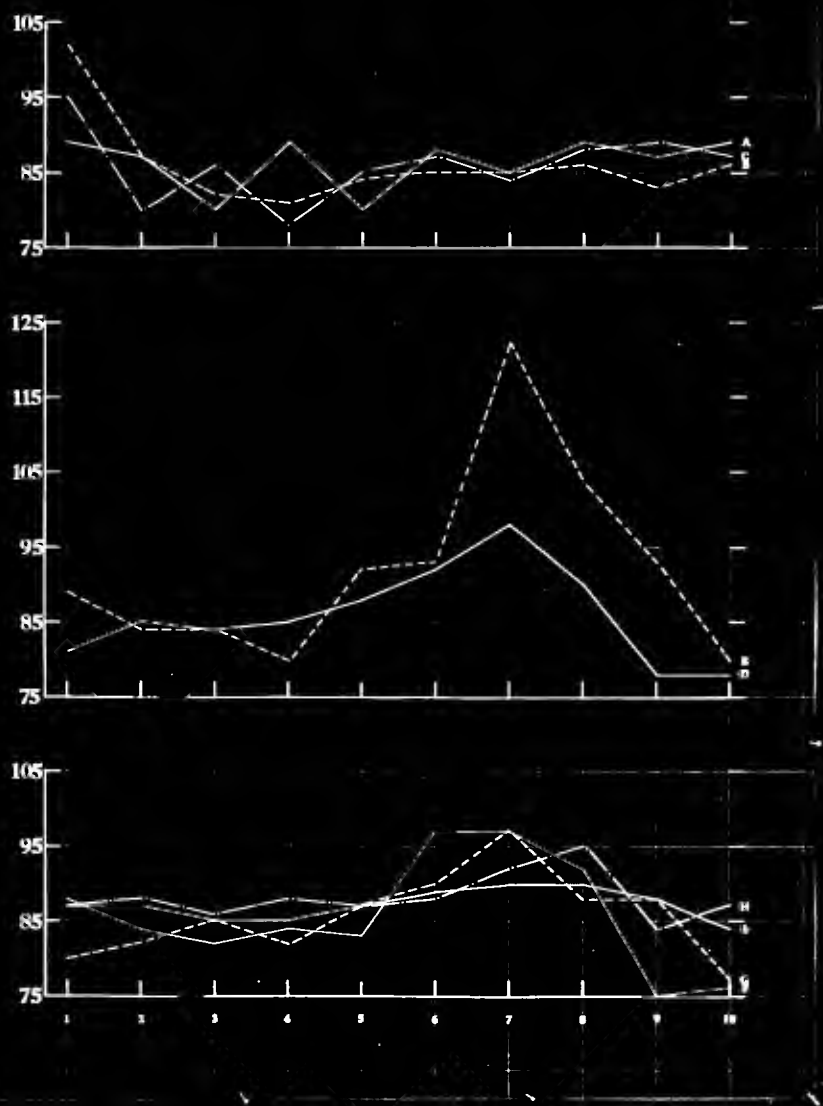

Fig. 11 - Pulse Readings - Reactor 1

Reactor:(2) Age: 9

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	80	90	87	93	97	94	90	86	97	88		12:11:22
Pulse	81	82	90	87	89	91	87	86	87	87		12:12:22
Pulse	89	89	85	87	87	87	86	84	87	83		12:14:22
Pulse	95	88	87	84	88	94	101	89	84	75	DB(1)	12:15:22
Pulse	84	89	89	89	92	109	112	85	84	87	DB(2)	12:18:22
Pulse	80	85	85	86	87	90	94	85	79	80	NW(1)	12:20:22
Pulse	89	88	83	85	85	90	97	87	80	78	NW(2)	12:21:22
Pulse	92	89	87	87	89	96	95	87	84	80	Cm L	1:11:23
Pulse	89	85	87	86	89	90	90	91	88	87	Read	1:12:23

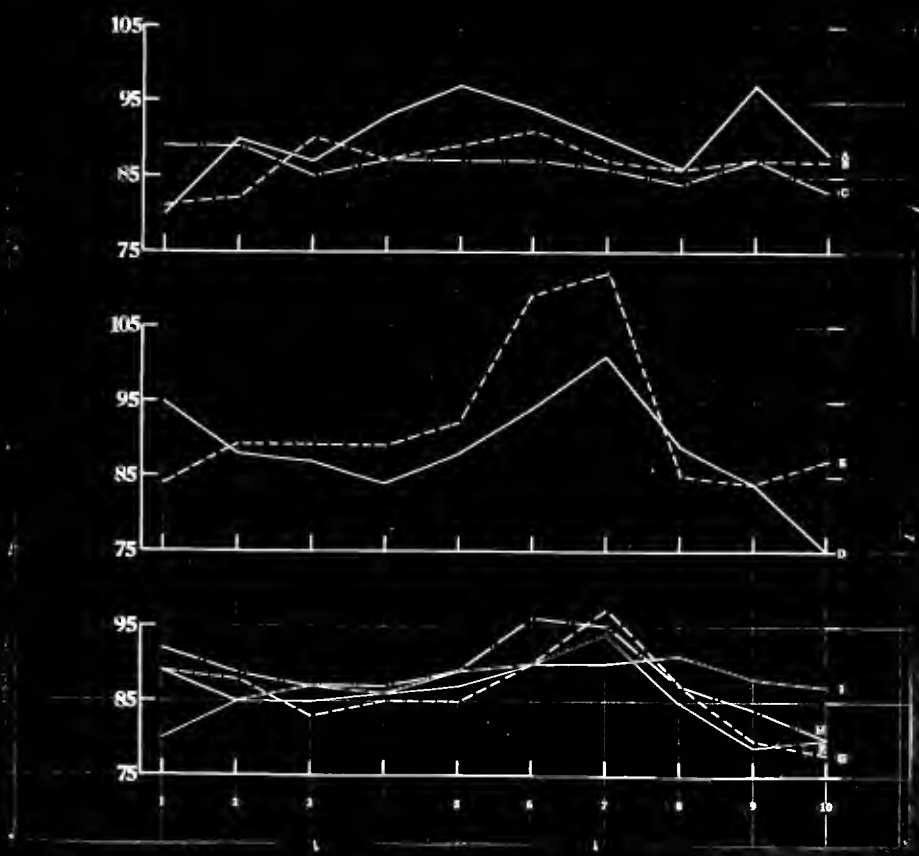

Fig. 12 – Pulse Readings – Reactor 2

Reactor: (3) Age: 9

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	89	87	84	89	89	88	83	87	86	85		12:11:22
Pulse	87	89	84	84	87	89	88	84	80	86		12:12:22
Pulse	90	89	89	85	86	90	82	80	80	81		12:14:22
Pulse	85	80	89	88	94	106	98	83	80	77	DB(1)	12:15:22
Pulse	89	87	89	90	97	84	96	96	88	87	DB(2)	12:20:22
Pulse	86	88	88	90	96	99	100	89	87	83	NW(1)	12:21:22
Pulse	89	90	89	89	94	98	99	88	85	85	NW(2)	1:11:23
Pulse	90	91	91	88	90	94	92	80	87	88	Cm L	1:12:23
Pulse	83	84	85	85	84	96	96	89	89	88	Read	1:16:23

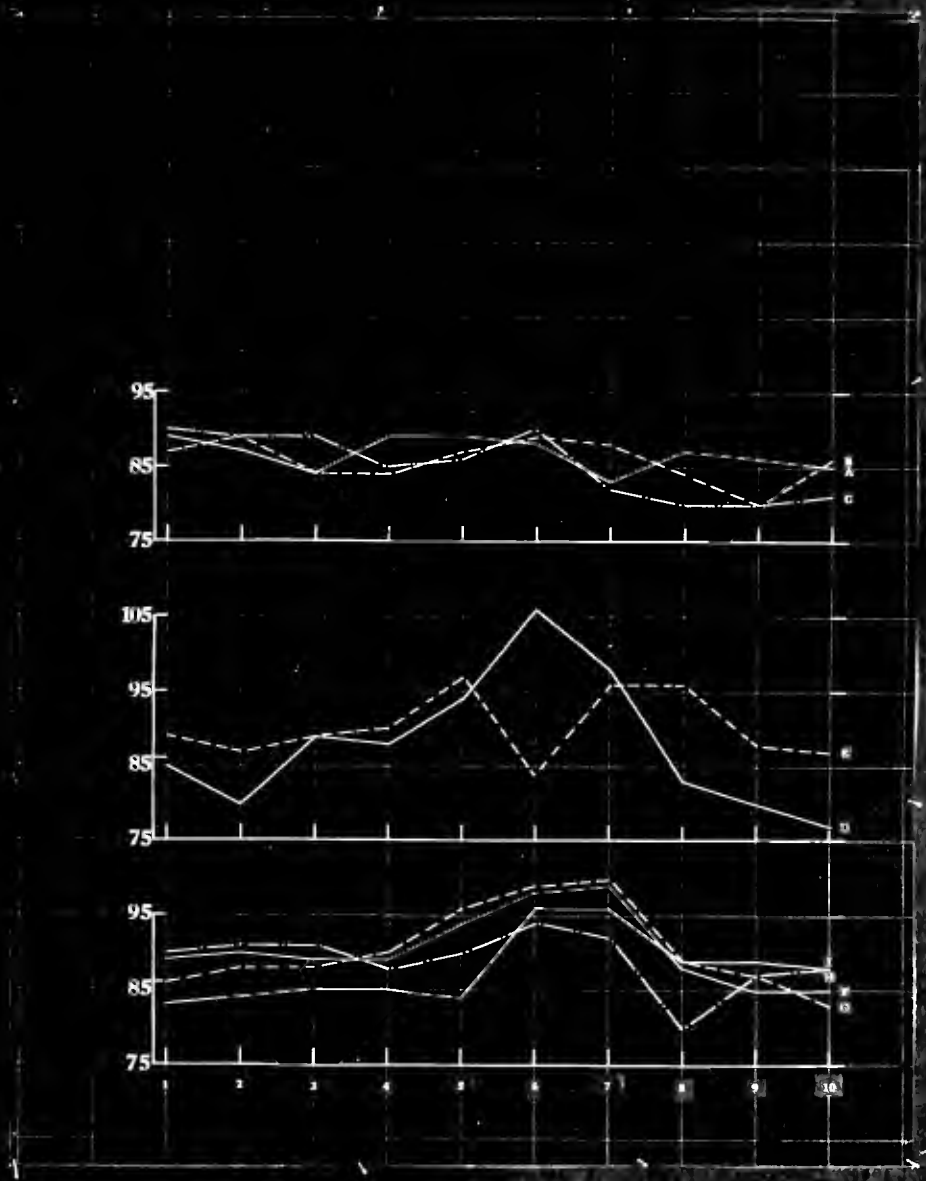

Fig. 13 – Pulse Readings – Reactor 3

Reactor: (4) Age: 9[3]

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	83	80	81	80	83	88	87	83	87	83		12:11:22
Pulse	87	89	87	89	86	84	87	86	84	84		12:12:22
Pulse	86	87	87	87	89	88	87	88	89	89		12:13:22
Pulse	87	85	83	87	89	88	98	95	95	93	DB(1)	12:14:22
Pulse	88	88	87	87	99	98	103	85	84	82	DB(2)	12:15:22
Pulse	89	90	86	82	94	98	96	89	83	86	NW(1)	12:18:22
Pulse	87	87	89	86	90	94	95	87	84	85	NW(2)	12:19:22
Pulse	87	88	88	87	88	95	97	89	90	88	Cm L	12:20:22
Pulse	87	89	90	87	89	97	95	85	87	87	Read	12:21:22

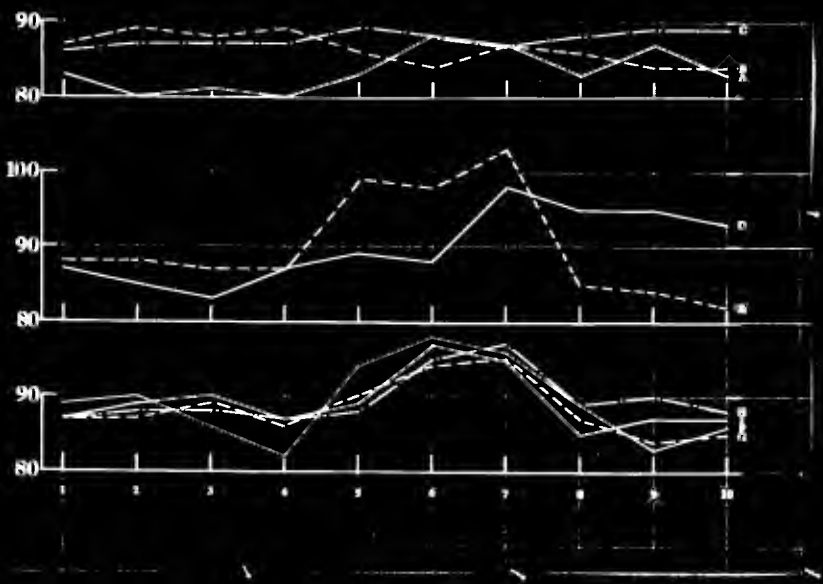

Fig. 14 - Pulse Readings - Reactor 4

Reactor: (5) Age: 6 y

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	84	79	75	79	78	80	77	81	82	82		12:11:22
Pulse	77	78	75	76	82	78	80	78	77	76		12:12:22
Pulse	80	77	79	82	82	80	82	79	84	82		12:13:22
Pulse	80	87	82	87	89	93	97	97	85	90	OB(1)	12:14:22
Pulse	79	83	85	84	87	94	99	89	80	85	OB(2)	12:15:22
Pulse	89	85	84	83	87	89	90	89	87	86	NW(1)	12:18:22
Pulse	84	83	86	83	88	87	88	83	83	81	NW(2)	12:19:22
Pulse	83	86	84	84	92	94	94	79	84	85	Cm L	12:20:22
Pulse	86	86	87	87	88	96	97	89	84	82	Read	12:21:22

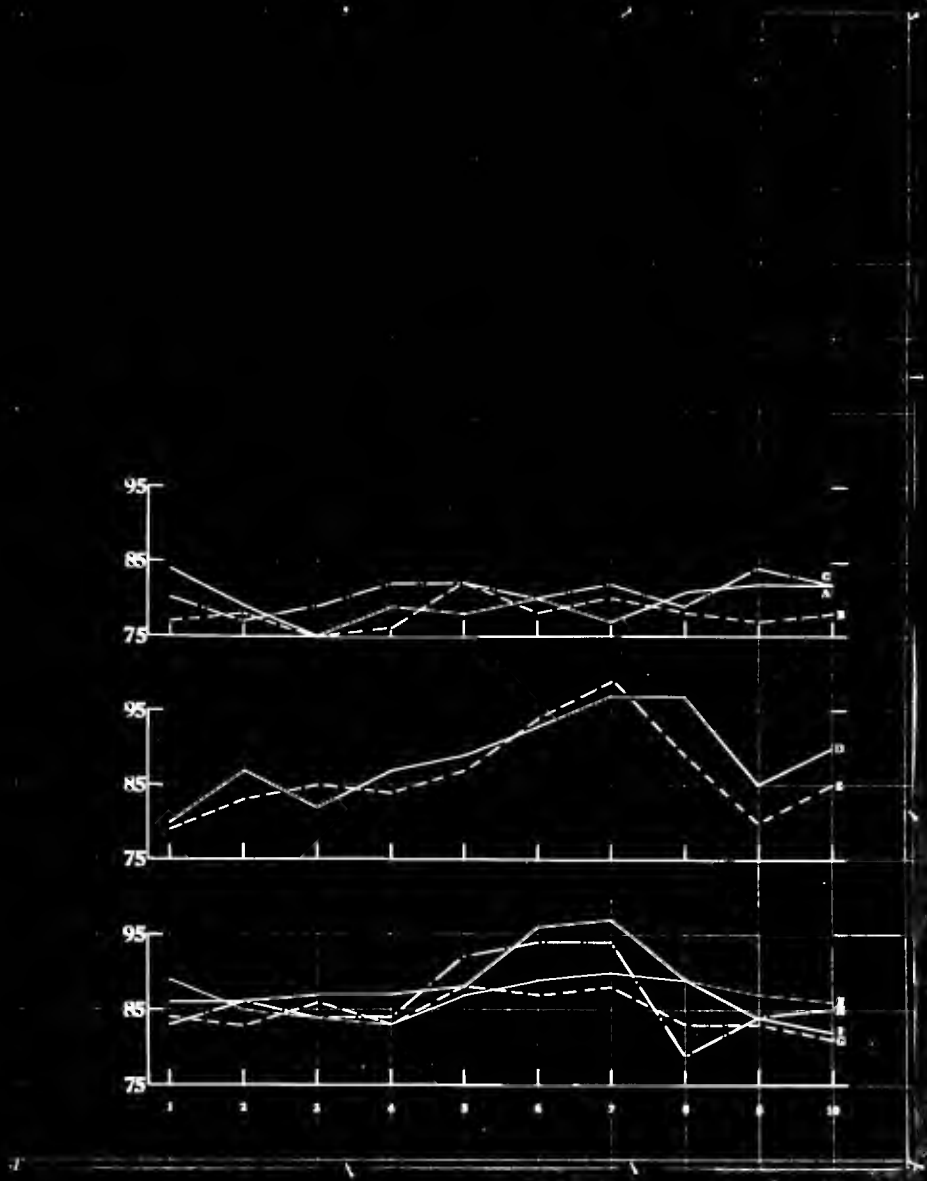

Fig. 15 - Pulse Readings - Reactor 5

Reactor: (6) Page: 9

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	91	89	91	89	85	85	87	82	85	85		1:9:23
Pulse	82	88	86	88	86	83	89	89	87	86		1:10:23
Pulse	92	87	80	89	89	89	90	90	90	89		1:11:23
Pulse	92	85	86	84	96	96	113	97	95	94	DB(1)	1:12:23
Pulse	78	80	78	79	106	113	117	79	83	83	DB(2)	1:15:23
Pulse	82	82	83	82	87	92	93	89	80	82	NW(1)	1:16:23
Pulse	87	87	85	86	85	92	94	87	88	87	NW(2)	1:17:23
Pulse	88	87	81	88	87	92	90	82	88	90	Cm L	1:19:23
Pulse	86	87	86	85	88	90	92	86	86	87	Read	1:22:23

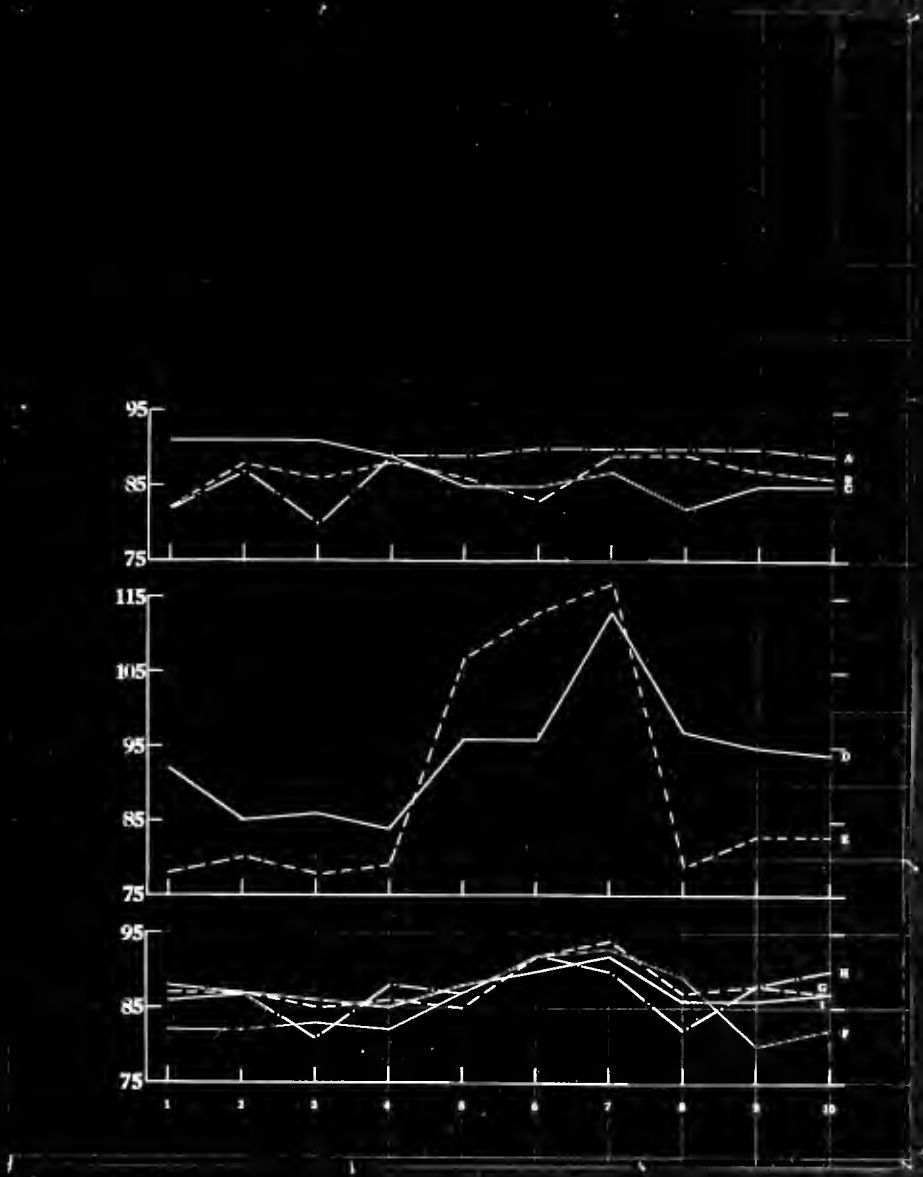

Fig. 16 – Pulse Readings – Reactor 6

Reactor: (7) Page: 8

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	90	94	89	86	92	90	93	94	92	93		1:8:23
Pulse	90	92	92	92	92	88	90	90	92	93		1:9:23
Pulse	90	92	92	91	90	93	93	93	92	93		1:10:23
Pulse	95	95	95	94	92	100	102	100	99	95	DB(1)	1:11:23
Pulse	90	89	89	91	102	101	107	85	94	94	DB(2)	1:12:23
Pulse	93	93	93	93	96	98	101	95	92	93	NW(1)	1:15:23
Pulse	90	90	91	90	97	103	105	92	92	92	NW(2)	1:16:23
Pulse	94	96	96	96	96	103	105	100	100	95	Om L	1:19:23
Pulse	94	93	93	92	97	100	100	101	97	94	Read	2:16:23

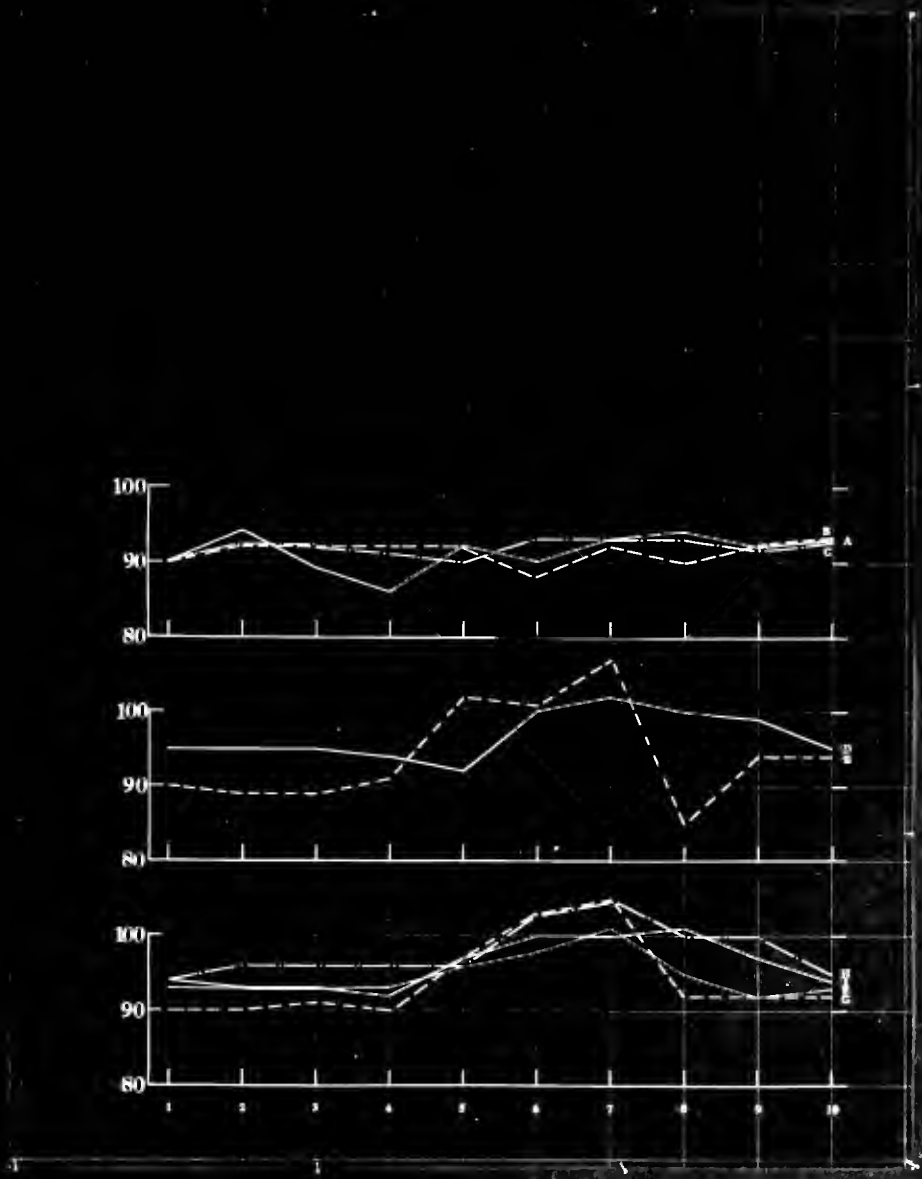

Fig. 17 - Pulse Readings - Reactor 7

Reactor: (8) Page: 8

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	84	87	85	84	84	86	85	86	87	85		1:23:23
Pulse	86	85	83	82	86	86	84	87	86	85		1:24:23
Pulse	88	87	87	88	86	87	87	88	88	88		1:25:23
Pulse	89	89	87	87	107	107	106	96	94	93	DB(1)	1:26:23
Pulse	84	82	82	84	101	100	100	93	84	81	DB(2)	1:29:23
Pulse	84	85	85	85	85	89	90	80	83	84	NW(1)	1:30:23
Pulse	84	87	87	85	88	91	96	91	90	88	NW(2)	1:31:23
Pulse	82	82	83	82	87	94	93	91	86	87	Om L	2:1:23
Pulse	84	86	82	82	86	90	90	84	84	82	Read	2:2:23

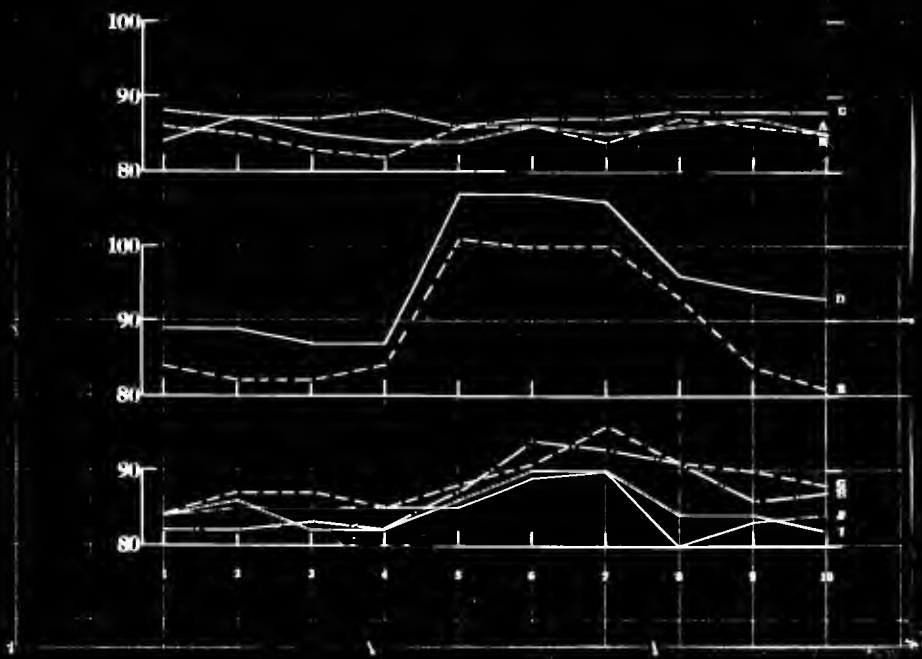

Fig. 17 - Pulse Readings - Reactor 8.

Reactor: (9) Age: 8

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	88	86	84	86	88	88	88	87	89	89		1:23:23
Pulse	90	92	92	92	93	91	92	93	92	90		1:24:23
Pulse	90	90	90	88	88	90	91	90	90	90		2:5:23
Pulse	84	84	86	86	90	94	94	86	86	87	DB(1)	2:6:23
Pulse	88	88	88	88	103	98	102	94	88	84	DB(2)	2:7:23
Pulse	85	88	88	88	93	93	94	89	86	87	NW(1)	2:8:23
Pulse	86	86	88	86	88	95	94	90	90	90	NW(2)	2:9:23
Pulse	96	94	90	94	95	97	100	95	88	90	0mL	2:12:23
Pulse	89	88	89	89	89	91	90	89	92	90	Read	2:13:23

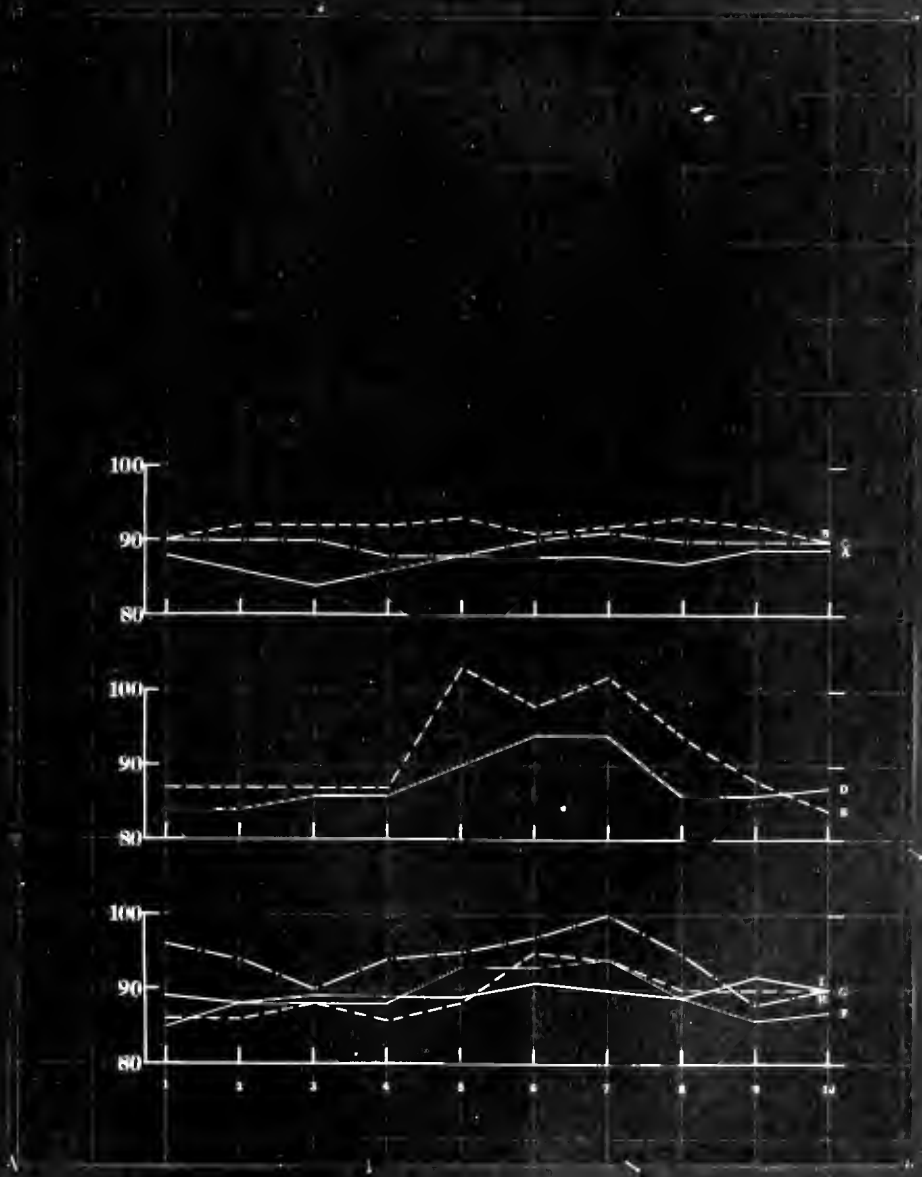

Fig. 19 - Pulse Readings - Reactor 9

Reactor: (10) Age: 9[1]

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	88	90	90	88	90	89	87	87	89	89		1:28:23
Pulse	84	81	84	84	82	84	83	83	84	84		1:29:23
Pulse	88	86	84	84	84	83	84	86	88	85		1:30:23
Pulse	82	84	84	82	85	97	98	89	81	86	DB(1)	1:31:23
Pulse	80	82	83	82	87	96	96	80	83	83	DB(2)	2:1:23
Pulse	81	80	81	81	82	86	92	82	82	83	NW(1)	2:2:23
Pulse	83	84	83	83	86	92	94	88	87	88	NW(2)	2:5:23
Pulse	83	83	85	83	89	90	88	85	86	80	Cm L	2:6:23
Pulse	94	93	93	93	94	98	100	98	97	96	Read	2:7:23

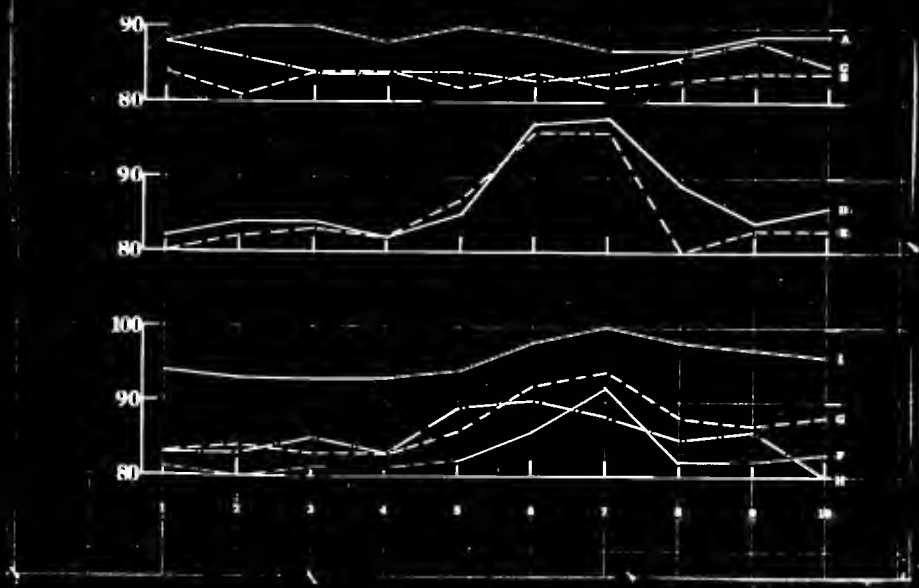

Fig. 20 — Pulse Readings — Reactor 10.

Reactor:(11) Age: 9

Read:	1	2	3	4	5	6	7	8	9	10	Test	Date
Pulse	92	96	96	90	98	92	92	90	92	94		2:8:23
Pulse	109	91	93	93	91	98	94	87	87	87		2:9:23
Pulse	88	84	84	83	82	82	84	83	84	84		2:12:23
Pulse	84	84	84	83	98	98	105	84	86	86	DP(1)	2:13:23
Pulse	84	81	81	81	94	97	97	85	84	84	DP(2)	2:14:23
Pulse	87	86	86	86	86	93	90	86	86	86	NW(1)	2:15:23
Pulse	80	81	80	81	84	94	96	88	86	83	NW(2)	2:19:23
Pulse	82	82	83	82	85	89	90	86	87	86	CM L	2:20:23
Pulse	86	87	83	83	88	92	92	85	84	86	Read	2:21:23

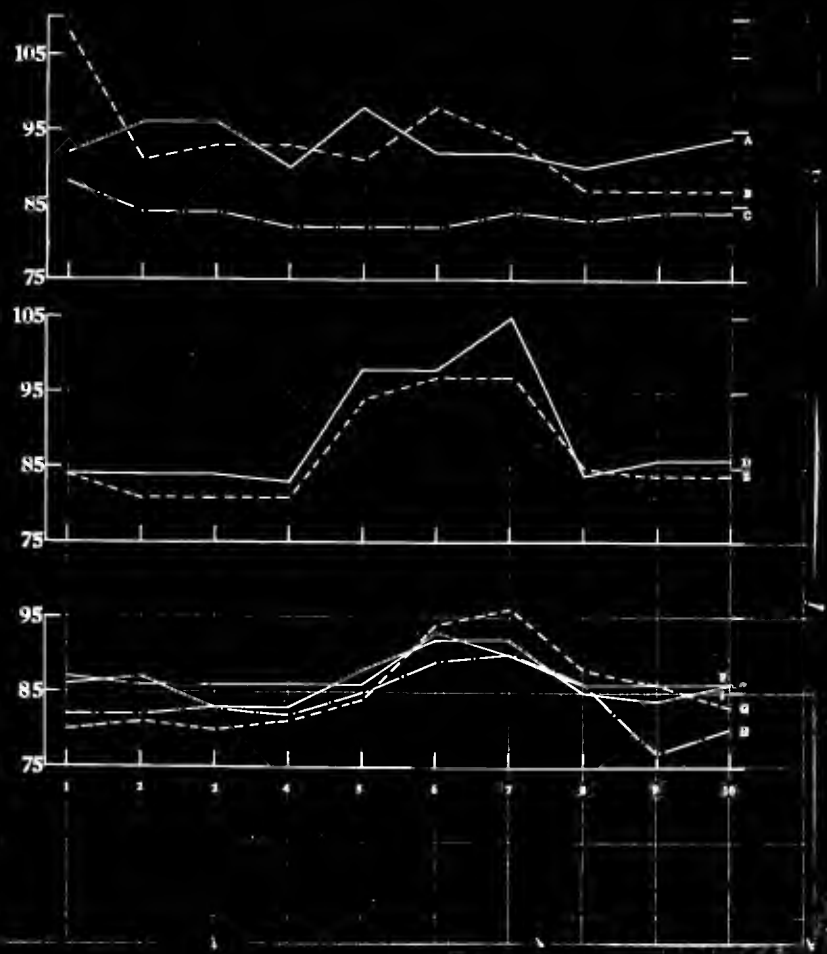

Fig. 21 – Pulse Readings – Reactor II

day is between 77 and 98. The normal rates of Reactors (5), (7), and (9) (girls) have a tendency to be a few points higher than the records for the boys. No conclusion can be drawn, however, in regard to sex difference since the number of cases is too small.

As in Reactors (F), (G), and (H), no regular increase and decrease is observable between successive readings in Reactors (1) to (11). As in the case of the former group, we will expect to find significant changes in rate, if they occur, between the fifth and seventh readings when the test exercises were given and between the seventh and tenth readings after the completion of the exercise.

A comparative study of the data shows that in every case there is a marked increase in pulse rate during both physical exercise periods. The range of frequency for the whole group during this period is from 85 to 122 beats per minute, which is the highest actual rate reached by any reactor during any experiment.

On the whole the younger children, Reactors (1) to (11), show both an actually and a relatively higher total increase in pulse rate during physical exercise, than the group of Reactors (F), (G), and (H), all of whom are adolescents. Both groups show a definite decrease in rate after the completion of the test.

In examining the records of pulse frequency for the group of reactors (1) to (11), we find that there is not one exception to an increase of rate during mental exercise. The change of rate is, on the whole, not as great as that occurring during physical exercise. The highest rate reached by any reactor during mental exercise was 105 and the lowest rate was 82 beats per second.

For the group as a whole the total rate of increase during a mental exercise period was greatest during both Number Work tests; the total rate of increase for this group during the Omitted Letter Test and the Reading Test was the same. No distinction can be drawn between the records of pulse frequency obtained from the group of reactors (F), (G), and (H) and those obtained from the group of reactors (1) to (11) during the various mental exercise periods.

In summarizing the experimental results, we find that there are effects observable in certain vascular processes, concomitant with periods of exercise, which occur regularly in the records of all of the reactors.

It is shown that the normal resting pulse for ten readings on three days, when no tests were given and the first four readings on the six days when tests were given

in the entire group of twenty reactors, ranges from 60 to 108 beats per second. These limits represent two extreme deviations, the 108 frequency being the first reading on the second day for Reactor (11). It was followed by a drop to 91 in the second reading. The pulse rate 60 occurred ir the first four normal readings of Reactor (E) on the fifth day of the experiment.

The adults showed a range of normal pulse rate from 60 to 91, the greatest number of readings occurring between the frequencies of 65 and 80.

In the case of the three Reactors (F), (G), and (H), all of whom are girls, the normal readings ranged from 67 to 89 pulsations per minute with the readings between 75 and 80 occurring most frequently.

In the group of children reactors (1) to (11), the normal rate which occurs most frequently is for the boys between 80 and 89,and for the girls the range is between 84 and 92 pulsations per minute.

Although there were only three reactors in the adolescent period ((F), (G), and (H)) the range of normal readings for these three cases falls between that for the children and that for the adults.

The physical exercise was given to all of the reactors for one minute at the beginning of the fifth, sixth, and

seventh readings, and the pulse rate taken during the exercise. In the case of the reactors upon whom blood pressure was taken, the pulse reading was counted for approximately thirty seconds during the exercise and for thirty seconds following the exercise.

The results obtained show that experiments which take readings only before and after the test lose the record of a significant series of changes in the course of the pulse rate.

Results of the physical exercise test upon adults show that there is an increase in pulse rate, accompanying the exercise, in every case except one, Reactor (B). The record of this reactor seems to be little affected by the exercise given.

All of the records on the children show an increase of pulse rate during physical exercise. In the case of all twenty reactors there is a decrease in pulse rate upon the cessation of exercise.

The actual changes in pulse rate, occurring during the periods of mental exercise are less than in the case of physical exercise, but the general trend of the curves is the same, an increase in rate occurring during exercise and a decrease following the completion of the work.

The fluctuations in systolic and diastolic blood

pressure are not concomitant with changes in pulse rate. There is no observable regularity in the increasing and decreasing pressure and we must conclude that unlike the pulse rate, the blood pressure is not affected by the physical and mental exercise given in this investigation.

TABLE I

DIFFERENCES BETWEEN READINGS

FIRST DAY - NORMAL

Reactor	Systolic	Diastolic	Pulse
1			-2-7 9-9 8-3 4-2 2
2			10-3 6 4-3-4-4 11-9
3			-2-3 5 0-1-5 4-1-1
4			-3 1-1 3 5-1-4 4-4
5			-5-4 4-1 2-3 4 1 0
6			-2 2-2-4 0 2-5 3 0
7			4-5-3 6-2 3 1 2 1
8			3-2-1 0 2-1 1 1-2
9			-2-2 2 2 0 0-1 2 0
10			2 0-2 2-1-2 0 2 0
11			4 0-3 8-6 0-2 2 2
A			
B			
C			
D	2 6-6-2 0 6-2-4 2	4 2-4-2-4 4-4 2-2	1 2-4 2-1-1 0 1 2
E	-4-2 2-4 0 2 2-6 6	-4 2-2 0 0-2 2-2 4	0 0 0 2-2 0 0-2 1
F	-2 2-4 2-2 4 0 0-2	-2-2-2 4-2 2 0 0-2	0 1-2 0 0 2 0 0-2
G	-6 2-4 4-2 2-4 4 0	-4 2 0 2-4 4-2-4-2	-1 2 0-2 1 1-2 0 1
H	4 2-4 0-2-2 2-2 2	4 0-4-2 0 0 2-6-4	-1 0 0 0 0-1 1 1-2
I	-2 210-2 0 0 2 2-2	-6-4 4 6-2 4-4 6-4	4 1 3-3 2-2 0 0 0

TABLE II

DIFFERENCES BETWEEN READINGS

SECOND DAY - NORMAL

Reactor	Systolic	Diastolic	Pulse
1			-15-5-1 3 1 0 1-3 3
2			1 8-3 2 2-4-1 1 0
3			2-5 0 3 2-1-4-4 6
4			2-2 2-3-2 3-1-2 0
5			1-3 1 6-4 2-2-1 1
6			6-2 2-2-3 6 0-2-1
7			2 0 0 0-4 4-2 2 1
8			-1-2-1 4 0-2 3-1-1
9			2 0 0 1-2 1 1-1-2
10			-3 3 0-2 2-2 1 1 0
11			-17 2 0-2 7-4-7 0 0
A			
B			
C			
D	-4 2 0 2-4 2-2 0 0	2-2 0-2-2 4-6 0-2	0 3 0 1-1-1 1 1 0
E	4-2-2 2-4 0 2 0-2	4-4-4 6-2 0 2 0-2	-2 0 1-1-1 2 0 1-1
F	4-2-2 0-2 4-4-2 0	-2-2 0 0-2 4-2 0 0	4-1 0 0 1 1 0-2 2
G	-6 2 2-6 2 2-4 4 2	-4-4-2-4 2 4-4 2 4	0 1-3 3-3 4 0-1 0
H	-4-2 4-2 2-2-2 0 2	-4-2 4-2-2 4-2 2 4	2 0 0-1 0 0-1 1-2
I	8-3 0 2-810-2 4 2	-2 4 0-2-2 4 0 2 4	2-1 0 1-3-2 0 0 0

TABLE III

DIFFERENCES BETWEEN READINGS

THIRD DAY - NORMAL

Reactor	Systolic	Diastolic	Pulse
1			-15 6-8 7 2-3 4 1-2
2			0-4 2 0 0-1-2 3-4
3			-1 0-4 1 4-8-2 0 1
4			1 0 0 2-1-1 1 1 0
5			-3 2 3 0-2 2-3 5-2
6			5-7 9 0 0 1 0 0-1
7			2 0-1-1 3 0 0-1 1
8			-1 0 1-2 1 0 1 0 0
9			0 0-2 0 2 1-1 0 0
10			-2-2 0 0-1 1 2 2-3
11			-4 0-2 0 0 2-1 1 0
A			
B			
C			
D	-4 2 0 2-4 2 0 0 4	2-2 0-2-2 4-6 0-2	0 3 0 1-1-1 1 1 0
E	4-2-2 2-4 0 2 0 0	4-4-4 6-2 0 2 0-4	-2 0 1-1-1 2 0 1-1
F	4-2-2 0-2 4-4-2-2	-2-2 0 0-2 4-2 0 0	4-1 0 0 1 1 0-2 2
G	-6 2 2-6 2 2-4 4 2	-4-4-2-4 2 4-4 2 4	0 1-3 3-3 4 0-1 0
H	-4-2 4-2 2-2-2 0 2	-4-2 4-2-2 4-2 2 4	2 0 0-1 0 0-1 1-2
I	8-6 0 2-810-2 4 2	-2 4 0-2-2 4 0 2 4	2-1 0 1-3-2 0 0 0

TABLE IV

DIFFERENCES BETWEEN READINGS

FOURTH DAY - FIRST PHYSICAL EXERCISE

Reactor	Systolic	Diastolic	Pulse
1			4-1 1 3 4 6-8-12 0
2			-7-1-3 4 6 7-12-5-9
3			-5 9-1 612-8-15-3-3
4			-2-2 4 2-110-3 0-2
5			7-5 5 2 4 4 0-12 5
6			-7 1-212 017-16-2-1
7			0 0-1-2 8 2-2-1-4
8			0-2 020 0-1-10-2-1
9			0 2 0 4 4 0-8 0 1
10			2 0-2 3 2 1-7-5 2
11			0 0-115 0 7-21 2 0
A	-2 2-2 0 2-6 8 0-10	2-4 2 4-2-4-210-8	2-2-2 6 2 1-11 0-2
B	0 2-4 6 0 0-8 0 0	-4-2 4 4-6-2 2 4-4	3 0-2 1-11 0 9-4 3
C	6 2 0 2-4-2-2 0 2	-8 4 2 2-8-4 0 2 6	-2 0 0 4 6 7-20 3 1
I	0 0 0 0-4 0 2 0 0	-2-2 0 8-10 2 4 0-2	-2-2 0 5 1 8-12-8 3
E	2-6 0 0 0 4-8-6 6	4-4 0-4 0 2 8-4 4	1 0-1 8 5 0-10-2-4
F	4 0-2 2 2 0-8 2 0	-4-6 0 0 2 0-2 4-2	-1 0 0 2 1 9-12 2-1
G	-2 0 0 0 2-4-2 0-2	-4 4 2 4 0-2-4 0 0	-2-1 2 5 3 4-9-4 2
H	2 0 0-2-4 2-2 4-4	-4 2-2 4 2-4-2 0 0	2-2 0 4 5 3-8-5-5
I	-2 4 0 0-14-4-8 4 0	-2 4 0 6-4 2-12 4-2	-1 1-2 6 1 1-8-2 4

TABLE V

DIFFERENCES BETWEEN READINGS

FIFTH DAY - SECOND PHYSICAL EXERCISE

Reactor	Systolic	Diastolic	Pulse
1			-5 0-412 129-18-11-13
2			5 0 0 317 3-17-1 3
3			-2 2 1 7-1312 0-8-1
4			0-1 0 2-1 5-18-1-2
5			4 2-1 3 7 5-10-9 5
6			2-2 127 7 4-28 4 0
7			-1 0 211-1 6-22 9 0
8			-2 0 217-1 0-7-9-3
9			0 0 015-5 4-8-6-4
10			2 1-1 5 9 0-16 3 0
11			-3 0 013 3 0-12-1 0
A	2 0 2-8 0-2 8-2 0	2 2 0 2 2 0-2 0-4	-5 0-1 7 1 1-5-2 2
B	0-2 2 2-2-4 2-2 0	-4 0 0 2-4 4-2-2 0	-1 0 0-2 2-2-4 4 4
C	0-2 2-2 2 2-8 14-2	2-10 4 8-2-4-6 6 2	0-2 0 5 4 8-14 5-2
D	-4 2 2-4 4 2-10 0 2	-2 4-4 4 0 0-4-2 4	-1 3-1 1-4 4-4 1-1
E	-2 0-2 4-4 2 0-2 2	0 0 0 2 4 0-2-2 2	1-1 0?1-2 0-8-12-3
F	0 0 0 2 2-2-8 2 2	2 0-4 4 0-2-4-4 2	-2 1 0 2 1 2-3-3-5
G	-2 4-4 0 0 2-2 0 2	-2-2 2-2 4-4 0 0 0	1-2-1 4 5 5-9-3 2
H	2-2 0-4-4-2 0 0 2	-2-2 0 2 0 2-4 0-2	0-4 1 5 5 1-9-7 1
I	-2 0 0 2 2 4-4-6 0	0 4-2 2 4 6-2-6 6	2 0 0 5 9 5-4-15-4

TABLE VI

DIFFERENCES BETWEEN RATINGS

SIXTH DAY - NUMBER WORK (1)

Reactor	Systolic	Diastolic	Pulse
1			-4 -2 2 -1 1 4 0 -5 -4 7 1
2			5 0 1 1 3 4 -9 -6 1
3			1 -1 0 5 4 1 -11 -3 0
4			1 -4 -4 12 4 -2 -7 -6 3
5			-4 -1 -1 4 2 1 -1 -2 -1
6			0 1 -1 5 5 1 -4 -9 2
7			0 0 0 3 2 3 -6 -3 1
8			1 0 0 0 4 1 -10 3 1
9			3 0 0 5 0 1 -5 -3 1
10			-1 1 0 1 4 6 -10 0 1
11			-1 0 0 0 7 -3 -4 0 0
A	-2 2 -4 6 0 2 0 -6 -2	0 2 2 -2 8 -2 2 -2 -4	-1 -5 4 -1 11 0 1 -6 -1
B	2 -2 6 -2 4 -4 6 0 -12	-2 4 -12 4 -2 -2 2 0 -6	-1 0 -3 2 -3 -1 -1 0 -4
C	-8 6 0 2 2 2 0 -2 -4	-6 0 -2 -2 4 -8 -2 4 0	-2 -1 1 2 3 1 -3 -2 -2
D	-2 0 2 0 2 2 -2 0 0	-2 4 2 0 4 2 -4 -6 2	-1 -2 1 5 2 1 -7 -2 0
E	-4 0 2 0 2 6 -10 2 0	-6 4 -6 8 -2 4 -6 -2 0	0 2 0 2 5 5 -18 7 -1
F	2 0 0 0 2 6 0 -4 -6	0 -2 2 -2 2 0 2 -2 0	0 -2 0 0 5 -1 -6 -2 -1
G	4 -2 0 2 2 -2 -8 4 -2	2 -2 0 -2 -4 0 4 2 -2	-2 1 0 0 3 -1 -4 0 1
H	2 -6 0 0 0 0 -2 2 0	0 2 0 6 6 6 -8 -2 -2	-1 2 -2 6 6 0 -9 0 -2
I	0 -2 0 -2 4 2 -4 -4 4	2 -4 0 -4 14 4 -2 -4 2	2 0 0 6 8 -2 -5 -1 -5

TABLE VII

DIFFERENCES BETWEEN BEFORE

SEVENTH DAY - NUMBER WORK (2)

Reactor	Systolic	Diastolic	Pulse
1			2 3-3 5 3 7-9 0-10
2			-1-5 2 0 5 9-10-7-2
3			2 0 2 6 3 1-11-2-4
4			0 2-3 4 4 1-9-3 1
5			-1 3-3 5-1 1-5 0-2
6			0-2 1-1 7 2-7 1-1
7			0 1-1 7 6 2-13 0 0
8			3 0-2 3 2 5-5-1-2
9			0 2-2 2 7-1-4 0 0
10			1-1 0 3 6 2-6-1 1
11			1-1 1 310 2-8-2-3
A	0-6 0 0 0 2 2-8 0	0-8 0 4 4 2-8-4 2	-3 0 0 3 1 3-10-2-2
B	0 2-2 0 4 6-12 0 2	2 4 0 0 4 4-12 0 6	0-4 0 2 3 4-7-4 2
C	0 2 0 6 2 4 0-4 2	0-2-2 8 0 2 0 4-4	-4 4-1 2 6 4-9 1-3
D	0-6 0 0 4 4-4-6 0	-2-4-2 2 6 2-8-6 2	0 1 0 1 3 4-5 0-2
E	4 0-2 0 8 0 0 0-10	2 0-2 2 4 0-2-10 4	0-1 1 211 5-6-10 0
F	-4 2-2 0 6 0-2-6 0	-4-4 4 0-2 0-6-6 0	-1 0-2 1 7-1-7-4-2
G	0 0 0 4 2 0-6-6 0	-2-10 0 6 0 6-2-12 0	-1-3 0 4 0 1-7 2 0
H	0-2 0 0 4 0-8-4-2	-2-6 0 2 6-2 0-4-4	-4-6 110 1-1-5 0 0
I	0 2 0 0 2 2-10 2-4	-2 2 0 6 2 0-8-10 6	4 0 0 2 9-1-11-2 1

TABLE VIII

DIFFERENCES BETWEEN READINGS

EIGHTH DAY - OMITTED LETTER

Reactor	Systolic	Diastolic	Pulse
1			1-2 2-1 1 4 3-11 3
2			-3-2 0 2 7-1-8-3-4
3			1 0-3 2 4-2-12 7 1
4			1 0-1 1 7 2 2 1-2
5			3-2 0 8 2 0-15 5 1
6			-1-6 7-1 5-2-8 6 2
7			2 0 0 0 7 2-5 0-5
8			0 1-1 5 8-1-2-5 1
9			-2-4 4 1 2 3-5-7 2
10			0 2-2 6 1-2-3 1-6
11			0 1-1 3 4 1-4-9 3
A	0-6 0 0 2 4-2-6 2	0-6 0 2 4 2-4-14 6	-2 1 0 5 2 1-3-4 1
B	-2-2 0 0 0 2-2 4 0	-8-2 0 012 2-8 0 0	-3 2 1 2 9-1-5-3 1
C	6-2 0 2 4 2-8 210	2 0 0 4-8 4 4 0-2	-2 0 0 1 2 6-4-1-1
D	0-4 0 0 4 8-6-6 0	4-2 0 2 2 6-4-4 2	-2-3 0 1 8 3-6-5 1
E	4-2-2 0 2 0-8 4 2	-2-2 2 0 4 2-10 4 0	0 0 0 1 6 6-13 0 0
F	0-2-2 2 6 2-14 0 0	-2 2 2 4 2 0-10 0 0	0 0 0 6 2-2 8 0 2
G	-2 0 2 0-2 0 4 4 0	0 2-2-2 2 4-4 0 4	-2 0 1-2 4 1-6 1-1
H	-8 2-4 4 4 0-10-6 0	-2 2-2 6 6-6-6 6 2	-1 1-4 4 5 5-8-9 5
I	-4 6-4 0 4-4-4-2 8	-4 6-210 6 4-10 0-2	1-1 0 5 3-2-9 5-4

TABLE IX

DIFFERENCES BETWEEN READINGS

NINTH DAY - READING

Reactor	Systolic	Diastolic	Pulse
1			0-2 0 2 2 1 0-2-4
2			-4 2-1 3 1 0 1-3-1
3			1 1 0-1 1 2 0-7 0-1
4			2 1-7 2 8-2-10 2 0
5			0 1 0 1 8 1-8-5-2
6			1-1-1 3 2 2-6 0 1
7			-1 0-1 5 3 0 1-4-3
8			2-4 0 4 4 0-6 0-2
9			-1 1 0 0 2-1-1 3-2
10			-1 0 0 1 4 2-2-1-1
11			1-4 0 5 4 0-7-1 2
A	-2 2 0-2 2 2 0-10-2	2 2 0-4 2-2 0-4 0	9-3 2 0 1 3-6-3-4
B	0-4 0 0 4 2-2-6-4	2-4 0-2 0-4 4-4-2	-2 1-1 1 2 2-5-4 0
C	-2 0 2 0 2 0 0-10 2	-4 0 0 2 4 6-14 0 4	-1 0 0 0 2 2-5 0 0
D	2 0 0 0 4 0-6 0 0	-2-2 0-2-4 2 6 0 0	0-1 0 0 1-4 4-1-1
E	-2-4 4 0 4 0-4-4 0	-2 0 0-2-2 0 4-2 2	1-1 0 5-1-1-3 0 1
F	2 0-6 0 4-2 0-6 2	2-2-6 0 2-4 0-6-6	-1 0-2 2 2 1-3-4 0
G	-4 2-4 4-4-6 2-2 2	0 2-2 0 4 0-6 0 2	0 1-1-1 5 1-6-1-3
H	-6 0 0-4 0 2-6 0-2	-2 0 0 8 0-2-3 2-4	-7 3-3 4-6 2 1-3 0
I	2-8-2 4 2 2-6-4 0	0-6 2 8 4 4-8 6 0	-3 0-2 3 0-1-1-2-3

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Vita

Mildred Elizabeth Day was born in Baltimore, Maryland, in 1901. Her elementary and secondary preparation was received in the Baltimore public schools and the Western High School. She received the degree of A.B. in 1920 at Goucher College.

The years 1920-1923 have been spent in graduate work in the Department of Psychology at the Johns Hopkins University. A Hopkins Scholarship was held during 1920-1922, and the degreeof M.A. was received in June, 1922.

The principal work has been done with Professor Knight Dunlap; Professor Buford J. Johnson; Professor Herbert Spencer Jennings, and Professor Arthur O. Lovejoy.